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DEPARTMENT OF ENERGY

Office of Energy Conservation and Solar Applications

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ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS

Advanced Notice of Proposed Rulemaking and Notice of Public Meetings

[6450-01-C]

DEPARTMENT OF ENERGY

[10 CFR Part 435]

ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS

Advance Notice of Proposed Rulemaking and Notice of Public Meetings

AGENCY: Department of Energy.

ACTION: Advance Notice of Proposed Rulemaking and Notice of Public Meetings.

SUMMARY: In August 1979, the Department of Energy expects to promulgate a final rule for building energy performance standards for new construction. A notice of proposed rulemaking is scheduled for publication in the Federal Register in February 1979. The purpose of this Advance Notice of Proposed Rulemaking is to make available to the public the form of the standards as presently envisioned by the Department, as well as support information available at the time of publication, and to invite the public's review and comments on the standards. Public meetings will be held for discussion and comments before the proposed standards are published.

DATES: Written comments in response to this notice to be filed by 4:30 p.m., December 15, 1978. Where appropriate, late comments to this notice will be considered by DOE prior to the issuance of the final rule. Requests to speak at the public meetings to be received by 4:30 p.m., local time, November 24, 1978. Speakers to be notified by 4:30 p.m., local time, November 28, 1978.

Meetings to be held on the following dates and times:

December 1, 1978, 9:00 a.m, Washington, D. C.;

December 6, 1978, 9:00 a.m., Chicago, Illinois; and

December 7, 1978, 9:00 a.m., San Francisco, California.

ADDRESSES: Comments on the document to:
U. S. Department of Energy
Office of Public Hearings Management, Room 2313
Box WC
2000 M Street, N. W.
Washington, D. C. 20461

Requests to speak at the Washington, D. C. meeting:
U. S. Department of Energy
Office of Public Hearings Management, Room 2313
Box WC
2000 M Street, N. W.
Washington, D. C. 20461

Requests to speak at the Chicago, Illinois, meeting:
U. S. Department of Energy
ATTN: Charles Swank
175 W. Jackson Boulevard
Chicago, Illinois 60604

Requests to speak at the San Francisco, California, meeting:
U. S. Department of Energy
ATTN: Robert Laffel
111 Pine Street, 3rd Floor
San Francisco, California 94111

Meeting locations:

GSA Auditorium, 18th & F Streets: N.W.;

Washington, D.C.; Ramada Inn, Mannhiem &

Higgins Roads, Des Plaines, Chicago, Illinois;

and San Franciscan Hotel, 18th & Market

Streets, San Francisco, California.

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION:

I. INTRODUCTION.

A. Planned Regulatory Action.
B. ANPR Purpose and Scope.

II. BACKGROUND OF THE STANDARDS.

A. Legislative Background.
B. Scope and Application of the Standards.

III. STANDARDS DEVELOPMENT PROGRAM: SUMMARY.

A. Analytical Programs.
B. Supplementary Studies: RUF's and RIF s.
C. Design Energy Budgets Selection.
D. Evaluation Techniques Analyses.
E. Updating Procedures Analysis.

IV. ISSUES RELATED TO DEVELOPMENT PROGRAM.

A. Alternative Approaches to Development Program.
B. Analytical Programs Issues.
C. Supplementary Studies: RUF's and RIF's.
D. Design Energy Budgets Selection.
E. Evaluation Techniques Analyses.
F. Updating Procedures Analysis.

V. PRELIMINARY FORMAT: DISCUSSION.

A. General Comments.
B. Specific Comments.

VI. SUPPORTING DOCUMENTATION.

A. The Docket.
B. Method of Obtaining Docket Material.

VII. COMMENTS RECEIVED TO DATE.

VIII. COMMENT PROCEDURE.

IX. ORAL PRESENTATIONS: CONDUCT OF MEETINGS.

APPENDIX I - PRELIMINARY STANDARDS FORMAT.

APPENDIX II - STATISTICAL ANALYSES PROGRAM.

I. INTRODUCTION.

I.A Planned Regulatory Action.

In February 1979, the Department of Energy (DOE), working jointly with the Department of Housing and Urban Development (HUD), plans to publish in the Federal Register proposed energy performance standards (the Standards) for new building construction. The Standards, planned to be issued in final form in August 1979 and to become effective no later than February 1980, are being developed in response to and in accordance with the Energy Conservation Standards for New Buildings Act of 1976, 90 Stat. 1144-1150, 42 U.S.C. 6831-6840, and Section 304 of the Department of Energy Organization Act, Pub. L. 95-91, 91 Stat. 965 et seq., 42 U.S.C. 7101 et seq. (see Section II.A. Legislative Background).

As legislated, the Standards will be performance type standards; i.e., they will include the goal(s) to be achieved and the applicable requirements, criteria and evaluation techniques. They will not include or prescribe the methods, processes or materials to be used to achieve the goal(s) delineated. Also, the Standards will be for new construction only, will be aimed at the design stage of the construction process, and will apply to buildings rather than their component parts.

As used in this Advance Notice of Proposed Rulemaking (ANPR), a building is defined as any structure to be constructed which includes provisions for a heating or cooling system or both, or for a hot water system.

I.B ANPR Purpose and Scope.

The primary purpose of this ANPR is to solicit from the public written questions, comments and suggestions on the Standards, prior to their proposal by DOE, scheduled for February 1979.

In order for the public to have sufficient information upon which to comment, this ANPR has been structured to include extensive discussions on as many Standards-related issues as possible. Ensuing sections accordingly deal with the legislative background to the Standards; the methodologies and status of the development program; issues related to the development program; a preliminary format for the Standards; discussions on the evolution of that format; and information on supporting documentation, comments received to date, the procedure for commenting on the program, and the process for public participation in the program.

There are two appendicies important to this presentation. The first is the Preliminary Standards Format previously mentioned. The second is a detailed description of the statistical analysis program which formed the primary basis for the preliminary estimations of the design energy budget levels.

Not included in this ANPR are discussions of those issues related solely to the application of the Standards by the State and local governments. This function is within the responsibility of HUD and is subject to separate regulatory action.

II. BACKGROUND OF THE STANDARDS. Cont'd

II.A Legislative Background.

The Standards are being developed and implemented pursuant to the Energy Conservation Standards for New Buildings Act of 1976 (90 Stat. 1144-1150, 42 U.S.C. 6831-6840), enacted as Title III of the Energy Conservation and Production Act (ECPA), Pub. L. 94-385 (90 Stat. 1125 et seq., 42 U.S.C. 6801 et seq.). The stated purposes of Title III are:

(1) To redirect Federal policies and practices to assure that reasonable energy conservation features will be incorporated into new commercial and residential buildings receiving Federal financial assistance;

(2) To provide for the development and implementation of performance standards for new residential and commercial buildings, standards which are designed to achieve the maximum practicable improvements in energy efficiency and increases in the use of nondepletable sources of energy; and,

(3) To encourage States and local governments to adopt and enforce such standards through their existing building codes and other construction control mechanisms, or to apply them through a special approval process.

In order to achieve these stated goals, Title III includes specific technical and administrative provisions.

Section 305 of ECPA requires that, to be in compliance with the Standards,

(1) a State must certify that the local governments have adopted and are implementing building codes or other construction control mechanisms which meet or exceed the requirements of the Standards; or

(2) a State must certify that it has adopted and is implementing, on a statewide basis or with respect to such area, a building code or other laws or regulations which provide for the effective application of the Standards; or

(3) a building design must be approved directly, through an approval process aimed at determining whether the proposed building design would be in compliance with the Standards.

However, the Secretary of HUD may determine that a building will not be subject to the Standards if a State has requested such a determination for an area within the State in which the construction of new buildings is not of a magnitude to warrant the cost of implementing the Standards. The Secretary of HUD may reject, disapprove, or require the withdrawal of any such certification after notice to such State and an opportunity for a hearing.

For Federal buildings, Section 306 of ECPA provides, "The head of each Federal agency responsible for the construction of any Federal building shall adopt such procedures as may be necessary to assure that any such construction meets or exceeds the applicable final performance standards promulgated pursuant to this title."

II.B Scope and Application of the Standards.

As previously discussed, the Standards are applicable to new commercial and residential buildings, which mean structures having designs that include provisions for a heating or cooling system or both, or for a hot water system. This means that a structure whose design does not have such provisions would not be subject to compliance with the Standards. Such structures might include unconditioned parking garages, for instance. Also, energy use areas not enclosed by a structure would not be required to be in compliance with the Standards. An example would be an open-air parking lot with lighting facilities.

The Standards are for buildings rather than their component parts and are applicable to the design stage of the construction process. As performance type standards, the Standards have four elements: the design energy conservation goals to be achieved, the requirements, the criteria and the evaluation techniques. The design energy conservation goals are expressed as design energy budgets, which are the energy consumption levels which the designs must not exceed. The requirements and criteria are the parameters upon which the design energy budgets are based. The evaluation techniques are the methods to be used to determine if a building design meets the requirements of the Standards.

The Standards are not prescriptive. This means that they do not include the processes, methods or materials to be incorporated into a building design in order for the design to satisfy the Standards. The Standards do not prescribe or prohibit any particular building design or any particular building components.

The Standards also will not include just one design energy conservation goal. Instead, they will include separate goals for different building classifications in different climatic zones.

III. STANDARDS DEVELOPMENT PROGRAM: SUMMARY.

The fundamental precept of the development program defined for the Standards was that the design energy budgets be technologically achievable, environmentally and economically acceptable, achieve the desired conservation of nonrenewable energy while encouraging the use of renewable resources, and reflect the source-energy and sociological "cost" of utilizing given fuels in the various regions.

The technological factors are defined and evaluated in the statistical analyses described in detail in APPENDIX II. The economic and environmental considerations are the subject of the economic and environmental studies, and the source-energy and sociological factors are the bases of the supplemental programs described in Section III.B.

DOE wishes to emphasize that the program described herein is but one of many approaches which could be followed in order to achieve acceptable design energy budgets. Other approaches are intimated throughout this document, and specific discussions are included in Section IV.A.

III.A Analytical Programs.

A driving force behind the developmental program was the objective that the Standards should be technologically achievable and environmentally and economically acceptable, while achieving the energy conservation desired and encouraging the use of renewable resources.

The statistical analyses were intended to deal with the technological aspects, and the environmental and economic studies with those considerations. A third study area, a regulatory analysis, was added in response to Executive Order 12044.

III.A.1 Statistical Analyses.

The basic approach of the statistical analyses was first to determine the design energy consumptions being achieved by recently constructed buildings and then to introduce technological improvements to those building designs and evaluate the resulting energy consumption levels. Supporting studies involved defining climatic regions, in response to ECPA requirements, and developing a set of building classifications.

The statistical analyses have been a joint effort of DOE and HUD. HUD contracted with the American Institute of Architects Research Corporation (AIA/RC) to collect and evaluate the data needed. In order to ensure that the work was technically comprehensive, AIA/RC subcontracted with experts in the design and construction fields. The subcontractors included: the National Association of Home Builders Research Foundation (NAHB/RF), The Ehrenkrantz Group, Brown Associates, Inc., Syska and Hennessy, Inc., Heery and Heery, and T. R. Arnold and Associates, Inc.

Also, in order to ensure that all technical concerns were addressed in the development activity to the extent feasible, AIA/RC established a Technical Advisory Group, consisting of individual architects and engineers who are members of the American Consulting Engineers Council; the American Institute of Architects (AIA); the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE); the Illuminating Engineering Society of North America; and the National Society of Professional Engineers/Professional Engineers in Private Practice.

Other Federal agencies, including the General Services Administration, were also consulted, as was the National Institute of Building Sciences (NIBS). The National Bureau of Standards (NBS) has participated in background research for the Standards and is being consulted on the proposed rule.

A two-phased program was established for the statistical analyses. Briefly, the first phase involved classifying buildings by type and location, obtaining data on and calculating the design energy consumptions of recently constructed buildings, and defining the climatic zones for all building classifications (except mobile homes, for which design temperature zones were used). This phase has been completed and the final report is available (see Section VI).

The second phase, which is in progress, involves several concurrent efforts:

(1) the technical redesign of representative buildings, within specified redesign limitations;

(2) the simulation of specific buildings, based on existing energy standards ASHRAE 90-75R, the HUD Minimum Property Standards (HUD/MPS) and the NAHB Thermal Performance Guidelines (NAHB/TPG), and the calculation of the design energy consumptions reflected in the simulated designs;

(3) the development and application of a parametric model to statistically project the design energy consumption distribution of the total nonresidential new construction universe; and

(4) the reevaluation of data and analysis anomalies, building classifications, and other factors to determine additional

studies or changes required for greater accuracy in the analyses.

The analytical model for both Phases I and II was chosen early in Phase I, after an exhaustive study of several alternative methods. The public domain programs examined at that time were found to be in the developmental stage and had not been used extensively on actual buildings.

AXCESS, a proprietary computer program, was chosen at that point because the short form of the program met the cost, time and data limitations of Phase I and the long form had the capabilities of performing the full hour-by-hour analyses anticipated for Phase II.

In the comparative analyses at the end of Phase II, the two public domain programs, DOE-1 and CERL-BLAST, were found still to be in the development stage, and NBLSD, another public domain program, was found to be incapable of analyzing plant energy usage, meaning its output was energy load only.

A detailed discussion of the statistical analyses program and its current status is contained in APPENDIX II of this document.

III.A.2 Impact Analyses.

III.A.2.a Environmental and Economic Analyses.

Extensive environmental and economic analyses are being conducted with respect to the Standards. An Environmental Impact Statement is being prepared, pursuant to the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321 et seq., and a separate economic analysis will also be prepared, expanding on the economic considerations pertinent to the Standards. Both documents will be included in the docket (see Section VI), their availability will be announced in the Federal Register, and public hearings will be held between the publication of the draft and final documents, scheduled for January and July 1979, respectively.

The analyses being prepared use 1980 as the base year and evaluate incremental changes for 1985, 1990, 2000 and 2020. Also, both are based on an assumption that the methods utilized in the technical redesigns of Phase II are the best available for predicting future trends and practice; i.e., that the technical redesigns are a viable indication of how building designs will look after the Standards become effective.

(1) Environmental Analyses.

The environmental analyses focus on: (1) onsite impacts, such as comfort, health and safety of the building occupants, as well as construction personnel; and (2) offsite impacts, such as occupational hazards, land use, and air and water quality.

A range of alternatives are being evaluated in the environmental analyses. These alternatives include: (1) no action, or the repeal of the legislated mandate for the Standards; (2) design energy budgets set at three different levels, the first as chosen for the Standards, the second less stringent, and the third more stringent; (3) component performance standards, instead of building performance standards; (4) the Standards with tax incentives; (5) prescriptive standards; (6) education and dissemination of information instead of the promulgation of standards; (7) different methods to encourage the use of renewable energy resources; and (8) energy pricing to effect energy conservation.

(2) Economic Analyses.

The economic analyses focus on: (1) the consumer's viewpoint, with respect to building costs, financing, habitability, and overall building desirability; (2) the construction industry's viewpoint, with regard to changes in training, the process of designing and building, and labor requirements; and (3) the code jurisdiction's viewpoint, relative to training and staffing requirements, financing, and potential conflicts with existing codes.

The studies are comprised of five major areas: (1) building economics and energy use, including considerations of life-cycle costs, both building oriented and nationally oriented; (2) energy impacts, including shifts in fuel mixes, net energy savings, and source energy requirements; (3) construction industry economics, including changes in output and effects on competition; (4) national economics, including effects on employment, the balance of trade, investments and national income; and (5) cost benefit analyses, combining the other four areas and assessing the sensitivity of the overall analysis to key parameters.

The last major study area, the cost benefit analysis which ties the other four study areas together, is considered a cornerstone of design energy budget selection, assuming that the present developmental program continues to be followed by DOE.

The studies are being closely coordinated with a fundamental life-cycle-costing research program being conducted by Oak Ridge National Laboratories (ORNL) and NBS. This program uses a prototypical house constructed at both ORNL and NBS, and computer simulations developed for the program. Approximately 20 improvements to the thermal integrity of the shell have been or are being systematically evaluated from a cost/benefit point of view. Coincidental research is also being conducted with respect to residential furnaces, air conditioners, heat pumps, and hot water systems, and the possible methodologies for integrating energy efficiency strategies for these subsystems into the shell design.

III.A.2.b Regulatory Analysis.

A Regulatory Analysis is being prepared. A summary of the draft Regulatory Analysis will be published with the proposed Standards and a summary of the final Regulatory Analysis will be published with the final Standards.

The Regulatory Analysis will analyze and evaluate the effects of setting the design energy budgets at different levels, using the same levels being considered in the economic and environmental studies. The analysis will describe those effects with respect to: (1) the existing regulated environment, and (2) the economic environment.

The latter will be provided by and abstracted from the economic analyses described in Section III.A.2.a.

The existing regulated environment is now being studied. On a Federal level, this includes: (1) the HUD Minimum Property Standards for Multifamily Dwellings, HUD Handbook 4910, Revision Number 5, April 1977; (2) the HUD Minimum Property Standards for One and Two Family Dwellings; (3) the Proposed Increases in Thermal Insulation Requirements for the HUD Minimum Property Standards for One and Two Family Dwellings, Federal Register, Vol. 43, No. 79, Monday, April 24, 1978; (4) the HUD

Mobile Home Construction and Safety Standards, Federal Register, Vol. 40, No. 244, Thursday, December 18, 1975; and (5) the Farmers Home Administration (FmHA) Construction Standards, Exhibit D to Farmers Home Instruction No. 424.1, CFR Part 1804, Subpart A, also known as the "Thermal Performance Standards."

The FmHA document is of particular note because it in part uses a performance concept. The document covers all aspects of residential buildings: walls, roof, glazing, infiltration controls, heating equipment, orientation on the site, etc. Also, three ways are allowed to certify compliance of a design with the standard: component U-value, overall U-value, and total structure performance. The latter is in essence a performance standard with test methods provided.

Public housing, publicly assisted housing and Federally insured housing are generally governed by the dual requirements of the HUD Minimum Property Standards and applicable State building codes. Also, for these construction sectors, technical requirements from the State organization responsible for the construction may be applied, depending on local policies.

For Federal construction, the controls range from the performance guideline of the General Services Administration's Energy Conservation Design Guidelines for New Office Buildings, to prescriptive requirements of other Federal agencies.

Outside the Federal regulatory sphere, there are three nationwide model building codes which are being included in the study: (1) the Basic Energy Conservation Code/1978, Building Officials and Code Administrators International, Inc., Chicago, Illinois; (2) the Standard Building Code (Revised), 1977-1978, Southern Building Code Congress International, Inc., Birmingham, Alabama; and (3) the Uniform Building Code, 1977 Supplement Appendix Chapter 53, Energy Conservation, International Conference of Building Officials, Whittier, California.

Finally, two building industry standards are under consideration: (1) ASHRAE Proposed 90-75R, Energy Conservation in New Building Design, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., February 1, 1978; and (2) the NAHB Thermal Performance Guidelines for One and Two Family Dwellings, National Association of Home Builders Publication Number 560.02, 1977.

ASHRAE 90-75R provides the foundation for the energy requirements of most existing building codes, while the NAHB Thermal Performance Guidelines are utilized by a large segment of the residential construction sector. Preliminary studies by DOE are aimed at comparing the energy conservation levels achieved by these two standards versus the projected energy conservation levels which may be achieved by different levels of the design energy budgets.

Also, once the design energy budget levels are selected and the process is fully developed, the details of that process will be included in the Regulatory Analysis, to complete the document.

III.A.2.c Energy Conservation and Renewable Resources Utilization.

The dual objective of the energy performance standards for new buildings is to achieve the maximum practicable improvements in energy efficiency, as well as increases in the use of nondepletable resources. The levels set for the design energy budgets will be selected to produce these two desired results.

(1) Energy Conservation.

The economic and environmental studies are focusing in part on the predicted savings in nonrenewable resources resulting from different levels of the design energy budgets. The results of these studies will provide information for the selection of the proposed and final design energy budgets. There are several ways possible to achieve energy conservation and each is being considered in the studies and analyses:

(a) Minimizing the use of nonrenewable resources.

(b) Minimizing the life-cycle costs involved.

(c) Allocating nonrenewable resources efficiently.

(d) Reducing nonrenewable energy imports.

(e) Establishing design energy budgets based on the marginal costs of nonrenewable resources.

(f) Increasing the use of renewable resources.

Note that it may be possible to conserve nonrenewable resources without increasing the use of renewable resources. However, it is the intent of the legislation to do both.

(2) Renewable Resources Utilization.

The increased use of renewable energy may be accomplished by simply setting the design energy budgets at levels which will be difficult to achieve, technically or economically by employing only energy conservation techniques. This is not as severe as it may first appear. Passive techniques such as natural ventilation, site orientation, natural daylighting, and others can effect substantive relief in the total building design requirements for energy utilization. This was proved fairly effectively in the technical redesign program of Phase II, which limited the renewable energy techniques available to the designers to only passive techniques, in order to minimize first-cost increases resulting from the energy-oriented redesigns. The exercise also demonstrated that energy could be saved with these relatively cost-effective design procedures.

It may also be possible to encourage the use of renewable resources by including a credit in the design energy consumption evaluation calculations. One method of doing so might involve resource utilization factors (RUF's), defined and discussed in Section III.B. Briefly, these factors are intended to account for the energy losses involved in delivering nonrenewable resources to a building site. If RUF's are set equal to or less than zero for renewable resources, this might encourage their increased usage. Or, it may be plausible to completely exclude from compliance those buildings whose designs attribute a certain percentage of their energy requirements to the use of renewable energy sources. Both of these possibilities are currently being studied.

There is one caution which should be stated: it is entirely possible that a building design may comply with the Standards, but the building itself will be energy inefficient. This could occur if the building design relies heavily on renewable energy use and therefore receives substantial credit for or is entirely excused from compliance with the Standards; that same building design could also reflect little or no insulation in its exterior shell. This is a recognized possibility, and it is an issue for which comments are particularly welcome.

It should also be noted that the Standards must be consistent with the Status Report on Solar Domestic Policy Review, Public Review Copy, August 23, 1978, and any subsequent issuances.

III.B Supplementary Studies: RUF's and RIF's.

As explained in the beginning of Section III, it was felt that the design energy budgets should be source-energy related and should reflect sociological considerations involved in the use of given fuels in various locations. To account for these concerns, resource utilization factors and resource impact factors are being investigated.

III.B.1 Resource Utilization Factors (RUF's).

Resource utilization factors (RUF's) are intended to account for the energy required to convert and transport raw energy from its source to the building line. For example, it takes three Btu's of energy at an electric generating plant to deliver one Btu of electricity to a building line; gas and oil, on the other hand, enter a building with only slightly less of a Btu content then they had when extracted from the ground.

Theoretically, RUF's can be computed for individual sites, but the practical application of this theory is, in reality, quite complex. Although the study is still in progress, DOE felt it would be desirable to reflect RUF adjustments for this ANPR. Therefore, national average RUF's were developed, again for the purposes of this ANPR only. The process involved using the equations in Chapter 12 of ASHRAE 90-75R and incorporating data from the following sources: American Gas Association, National Oil Fuel Institute, Council on Environmental Quality and DOE.

The RUF's thus calculated were:

Fuel	RUF
Oil	1.16
Gas	1.11
Electricity	3.04

These values were then used to develop regional combined RUF's, based on the fuel mixes of the original buildings in the Phase I data. The process is described in Section V.

The studies being conducted in this area concern not only how RUF's should be developed, but also whether or not they should be developed, especially with respect to their use in the energy performance standards for new buildings. Other ongoing studies relate to setting RUF's equal to or less than zero for renewable resources, in order to encourage their utilization in new building designs.

Finally, alternative methodologies for dealing with the energy required for fuel conversion and delivery are being studied. One such possibility involves utilizing marginal costs.

III.B.2 Resource Impact Factors (RIF's).

Where RUF's account for the technological (i.e., energy technology) costs of delivering fuel from the source to a building site, resource impact factors (RIF's) are intended to deal with the social costs of that delivery. The RIF concept is still embryonic; the studies are at present focusing on literature searches and preliminary numerical quantifications.

Health and enviromental considerations are being scrutinized, as well as the effects of government taxation and subsidies. The process is being carried out for each individual step in the energy conversion and delivery process. Here again, marginal costs are being explored as a possible alternative to the development of RIF's.

III.C Design Energy Budgets Selection.

Under the current developmental program, the design energy budgets will be selected after a review of all the data, analyses and results of the statistical analyses, and the three major impact analyses (e.g., economic, environmental and regulatory).

It is anticipated that individual design energy budgets will be selected for different classifications of buildings and for different geographic (e.g., climatic) regions. It is also anticipated that these design energy budgets will, in some manner, reflect source-energy considerations, as well as the sociological factors associated with the use of specific energy sources in given locations. At present, the RUF and RIF concepts are being seriously considered as a means of introducing these nondesign considerations.

DOE will maintain a record of the criteria used and the selection process developed. These data will be used to revise the Standards in the future.

III.D Evaluation Techniques.

An important element of a performance standard is the test methodology by which compliance with the standard is to be measured. In recognition of this fact, DOE has been and is currently sponsoring a number of research and development efforts aimed at producing meaningful evaluation techniques for building designs to determine if those designs are in compliance with the energy performance standards for new buildings.

III.D.1 DOE-1.

In 1976, the Energy Research and Development Administration (now part of DOE) initiated a program in conjunction with the State of California to develop a computer program for large-building energy analysis. Now called DOE-1 (formerly, CAL-ERDA), the program is in the public domain and is commercially available through a number of computer service networks.

The work on DOE-1 is continuing. It is being improved to expand its ability to model different aspects of design energy consumption. One specific effort, being conducted for the Lawrence Berkeley Laboratory, is to simplify the input requirements to the program and enhance its ability to model passive energy usage. Also, workshops relative to the program are being planned for design professionals. These workshops are currently anticipated for fiscal years 1979 and 1980.

III.D.2 Techniques Survey.

NBS is working with DOE on a survey of existing computer programs and manual techniques for analyzing design energy consumption. The result will be a comprehensive catalog of such methods, along with a description of their specific analytic approaches, where such information is available. Also, ASHRAE is beginning a complementary effort by developing a standard for documenting such computer programs.

III.D.3 ASHRAE Bibliography.

DOE is currently negotiating with ASHRAE to update its "Bibliography on Available Computer Programs in the General Area of Heating, Refrigerating, Air-Conditioning and Ventilating." ASHRAE, 1975.

III.D.4 Comparison Study.

Finally, a comparison is being conducted of four programs: AXCESS, DOE-1, CERL-BLAST and the ASHRAE Energy Calculation Committee Simplified Method. The objective of this preliminary study is to determine if the numbers produced by AXCESS for Phases I and II were reasonable relative to other calculation techniques using identical input wherever possible.

Four buildings were selected from the 168 buildings used in the technical redesign. The building types were: mercantile, office, hospital, warehouse.

The results of this study will determine the need for follow-on work which may include the expansion to more building types. The study began in August of 1978 and is scheduled for completion by mid-November 1978.

III.E Updating Procedures Analysis.

The Standards will be reviewed on a periodic basis, and updated and improved as deemed necessary. As currently envisioned, the updating process will take into account: energy performance; national goals and objectives, including balance of payments and imports of oil; energy and construction technologies, including renewable resources such as active and passive solar; environmental factors; estimated design vs. actual operational building energy consumption; consumer education and understanding of building energy related issues; micro- and macro-economic benefits costs; and the state of the art in the building community. DOE believes that, with improvements and advances in the factors indicated, more stringent design energy budgets will not only be possible, but advisable.

In support and anticipation of this updating activity, DOE will continue developing and improving the data base on hand, as well as the research into life-cycle costing micro- and macro-economics and pertinent environmental issues.

The updating cycle should be sufficiently frequent to effect the needed or desired conservation of nonrenewable energy resources; yet sufficiently infrequent as to not place an undue burden on those affected by the Standards. The first evaluation and update is therefore anticipated not to occur until 1982.

IV. ISSUES RELATED TO DEVELOPMENT PROGRAM.

IV.A Alternative Approaches to Development Program.

There are a number of approaches which could be followed in developing the energy performance standards for new buildings.

One alternative might be to use a purely statistical approach; i.e., to statistically analyze the designs of actual buildings and then select design energy budget levels which are more efficient than the average of those real buildings but still within the capacity of designers and constructors to design and build with minimal changes in existing techniques. A drawback to this approach is demonstrated by the discussions in Section V; i.e., this was the only approach available for this ANPR, and the resulting decisions were judgmental and subjective.

A second alternative might be to follow a purely economics oriented approach. This approach might build on life-cycle costing of buildings, with the design energy budgets set at a point where the higher mortgage payments and property taxes resulting from the theoretically more expensive first-costs are approximately offset by the lower utility bills. A problem with this approach is that mortgage rates are continually fluctuating, and life-cycle costing of buildings can be a complex procedure, sometimes depending on uncontrollable and unpredictable circumstances.

A more complex concept would be to use national life-cycle costing. This would require correcting for the unequal tax treatment of homeowners vs. corporations, and the effects of energy price regulations that do not provide consumers with adequate incentives to invest in conservation.

A third alternative would be to combine the statistical and economic concepts. This is the approach which DOE currently anticipates following, and it is described in Section III. Briefly, the approach involves developing a statistical data base centered around the design energy consumptions of actual buildings; incorporating considerations of economic costs and benefits, environmental factors and regulatory interactions; and evolving design energy budgets which reflect the appropriate levels of energy conservation within the confines of technology, economics and the environment.

There are also alternatives within alternatives, as might be expected with programs such as this. For example, the introduction of the source-energy related concept (i.e., the RUF's) with respect to the design energy budgets produces a number of possibilities.

One involves utilizing national average RUF's and developing regional average RUF's, using the actual fuel mixes demonstrated by real buildings. This was the approach used by DOE for the purposes of this ANPR. One drawback is that this approach inherently assumes that the fuel mixes demonstrated by those buildings will continue to be the fuel mixes demonstrated by future buildings. Also, at the time the data were collected, there may have been a fuel-related abnormality, such as a moratorium on the use of gas, in a given region. This would bias the regional RUF's developed on the basis of those actual fuel mixes.

To get around these two problems, a second approach might be to develop RUF's using the national averages, as was done for this document, but base the calculations on typical fuel choices instead of real ones; e.g., all-electric buildings, buildings with gas for air and water heating and electricity for air-conditioning, etc. The RUF's would automatically be regionalized by the fact that different fuel choices are typical for different regions of the country. For instance, in some areas, all-electric homes are predominant; in other areas, they are in the minority. Also, typical fuel choices imply prototypical building designs, and separate designs would be needed for each of the different building classifications.

Some of the problems inherent in this second alternative are: (1) the requirement to develop prototypical buildings and the problems surrounding such development; (2) the questionable statistical validity of selecting prototypical designs from available survey data; (3) the reality of being able to develop typical fuel mixes for complex buildings such as offices, hotels and hospitals; and (4) the adjoining problem of the builder being able to match his precise fuel mix with any of those selected for the Standards.

There is a third approach which would avoid the fuel mix problem altogether. It involves selecting a single fuel as the most critical to the nation (e.g., oil) and developing the Standards around the conservation of that fuel. The Standards would automatically conserve other fuels to the same extent. Even a single fuel mix could be used, such as oil heating and electric air conditioning. This particular combination is almost universally available, even in rural areas. One problem with this approach is that deciding on the most critical fuel could prove difficult if not impossible, especially considering that different fuels may be critical in different parts of the country, and that the fuel which is most critical may change in time.

As previously stated, these are only a few of the permutations and combinations available to DOE for the development and selection of design energy budgets for the energy performance standards for new buildings. Comments, questions or suggestions from the public, on these and any other alternative approaches, are invited.

IV.B Analytical Programs Issues.

IV.B.1 Statistical Analyses.

IV.B.1.a Phase I and Phase II Building Design Data.

There are a number of issues involving the data base and subsequent statistical evaluations.

First, when the data base was being compiled, the volume of potential information available made it impossible, within the time frame available for the statistical analyses, to include the entire new building population. Emphasis was therefore placed on those structures or building types which would represent the predominant construction volume over the next decade. The analyses are continuing and those building types that initially were not included are being examined. The issues directly related to this discussion are:

- Can the functions of those building types included in the data base be used to represent similar functions in building types not included in the original data base?
- Is it reasonable to assume that the design energy consumptions of multifunctional buildings can be dealt with

as simple additive composites of the design energy consumptions of the individual functions, or are there other effects which should be considered? (See the discussion on multiuse buildings in APPENDIX I.)

- If the construction of a building type, such as a coliseum, is of such small volume as to not contribute significantly to energy conservation, is it cost effective to require specific provisions for such building types?

Second, a few anomalies, which are currently being investigated, were discovered in the data base.

- Warehouses showed an unusually high level of design energy consumption, greater than professional judgment could immediately justify.
- Elementary schools apparently represented greater design energy consumption than secondary schools, which in turn were greater than colleges or universities.
- Multifamily low-rise residential structures appeared to behave in some ways like commercial high-rise structures and in other ways like single-family attached residential structures.

Next, the parametric data base was in a preliminary form when it was used for the design energy budget selection process for the preliminary format in APPENDIX I; it was in the process of being refined for greater statistical accuracy and representativeness. In addition, the original data base had not included energy considerations for domestic hot water. This energy factor is now being incorporated into the analyses.

The statistical analyses program is described in detail in APPENDIX II to this document. DOE is interested in responses to the procedures employed, and suggestions on improvements or alternatives to that procedure, not only for the initial promulgation of the Standards but also for subsequent revisions.

IV.B.1.b Climatic Zones.

At present, DOE does not foresee any problems with using the design temperature zones for mobile homes, which were taken from the HUD Mobile Home Construction and Safety Standards.

The climatic zones for all other building classifications, however, are being reexamined. The ones developed in the statistical analyses program are based only on temperature and are defined around the concepts of heating degree-days and cooling degree-days. The distributions for these two factors were obtained from the National Oceanographic and Atmospheric Administration, based on Test Reference Year (TRY) information for 37 Standard Metropolitan Statistical Areas (SMSA's).

The problems inherent in this procedure are: (1) the TRY's are considered only "typical," and weather variations away from these years can be substantial and different from one year to the next; (2) the weather for one SMSA may not be indicative of the weather in a neighboring SMSA in the same region; and (3) the use of temperature only as a single criterion for evaluating weather does not allow consideration for sun, wind and humidity effects on the weather.

In addition, only seven zones were defined in Phase I, and the spread of heating degree-days and cooling degree-days from zone to zone was different. This could present some discrepancies, not only between zones but also within zones where the spread is greater than it is in others. It is conceivable that more zones may be advisable, and that some method may be needed to base the definitions on more than just temperature.

IV.B.1.c Building Classifications.

As discussed in Section V, the building classification definitions are being reexamined. For instance, the buildings included in the "assembly" classification represent a great variation in design characteristics. Movie theater buildings and church buildings may be too dissimilar to permit their inclusion in the same building classification.

The supporting documentation also pinpointed overlaps in the "schools" classifications: middle schools, high schools, junior high schools, elementary schools and secondary schools were all originally considered, and individual schools in each varied with respect to the grades they included. The preliminary format lists only two school classifications, elementary and secondary, but the classifications which will ultimately be used in the proposed or final Standards are still in question.

It is also questionable whether enclosed shopping malls should be treated as very large stores, or large department stores should be in the same category as small "one-room" operations.

Similarly, differentiating between a hospital and a clinic, or a fast food restaurant and a full menu one, is not always clear cut.

It may also be necessary to reexamine the methodology used fo developing the classifications. They are ultimately based on definitions used in existing building codes. The intent was to employ terminology already familiar to builders and code officials. It is possible that a new system is needed for the Standards, one that deals with the energy related characteristics of a building, rather than its intended use. If so, how would builders and code officials reconcile their designs and their codes with these different definitions?

IV.B.1.d Process Energy.

In a number of building classifications, "process energy" plays an important role. Process energy is the energy required for the building's intended function; i.e., a restaurant uses energy for cooking and refrigeration, an industrial facility for manufacturing, etc.

DOE feels that the energy used for these purposes should not be considered in an energy efficiency evaluation of a building. Logically, then, process energy should also not be included in a similar evaluation of a building design.

This may not be easily practicable. Where is the line drawn between process energy requirements and nonprocess functions (space conditioning, domestic hot water heating, lights, etc.)? For example, is it possible to separate the hot water heating attributable to the process in a restaurant (dishwashers, for instance) and that attributable to the domestic uses? The problem is equally difficult in industrial buildings.

In addition, many facilities (both restaurants and industrial buildings) now follow the practice of using waste heat from process operations to heat their buildings or their water supplies, or even as input to still other processes. How can this be accounted for? For that matter, how can this be encouraged, since it does result in reduced nonrenewable energy usage?

Finally, can a precise definition of process energy be developed, one that would delineate its boundaries and would minimize or eliminate the problem of determining if an energy use is process oriented?

IV.B.2 Impact Analyses Issues.

IV.B.2.a Environmental and Economic Analyses.

The environmental and economic analyses are proceeding on the assumption that the technical redesigns of the Phase II program could be accepted as indicative of the trends that building designs would follow once the Standards are implemented.

Issues concerning or affecting the economic and environmental study programs are:

1. What data should be gathered and analyzed? How should these procedures be done?
2. What is the relationship between capital and operating cost as a function of heating fuel type, building systems, climate and fuel prices?
3. What are the sensitivities of fuel prices, interest rates, construction costs, and insurance costs?
4. What are the levels and types of energy conservation goals? (see discussion in Section-III.A.2(1))
5. Should other determinants be included, such as operating profiles, uncertainty of interest rates, future fuel price predictions, and technological developments?
6. What, if any, is the relationship between regional variation in energy consumption and building costs or energy prices?

In summary, DOE is soliciting comments on the scope of the environmental study.

IV.B.2.b Energy Conservation and Renewable Resources Utilization.

Many of the issues with respect to these two topic areas are already touched upon in the discussions in Sections III.A.2.c, IV.A, and APPENDIX I. Such issues include:

1. How can energy conservation be achieved through the Standards? What level of conservation should be considered the goal of these first Standards?
2. How can the use of renewable resources be encouraged through the Standards? Again, what level of utilization should be considered desirable for these first Standards?

3. Are RUF's and RIF's a valid means of affecting energy utilization; i.e., will setting the RUF's and/or RIF's equal to or less than zero for renewable resources encourage the use of such resources?

4. What types of energy should be included in the definition of renewable resources? The State of California does not include wood, where other discussions on the topic do.

5. Should all renewable resources be treated equally?

6. How should hydroelectric power be treated?

7. How should the passive use of renewable resources be included in the evaluation techniques, knowing that most existing computer and hand calculation methods do not take these considerations into account?

8. What assumptions should be made regarding the relationship between design and actual building energy consumption? Should this relationship affect the level of the design energy budgets? If so, how?

Comments on these and related issues are invited.

IV.C Supplementary Studies: RUF's and RIF's.

The fundamental issues related to RUF's and RIF's are as follows:

1. Are RUF's and RIF's valid concepts? If so, how should they be derived? Can they be derived? Should they be regional? Who should derive them?

2. Should RUF's and/or RIF's be used in the Standards? If so, how?

3. Should RUF's and/or RIF's be set equal to or less than zero for renewable energy sources?

4. Should the RUF's or RIF's for hydroelectric power be lower than those for electricity generated by plants using gas or oil as their primary fuel? The same question applies to nuclear energy, except that the RIF's may be higher because of the current costs of designing, developing and constructing nuclear power stations.

5. Are national RUF's sufficiently valid (assuming RUF's themselves are valid) for use in the Standards if regional RUF's cannot be calculated before the proposed or final Standard are promulgated?

6. What fuels should be assigned RUF's or RIF's? Is a resource such as wood considered a renewable resource eligible for a RUF or RIF of zero or less? (The State of California says "no".)

7. Are Btu's a good measure of the value to society of consuming an energy resource?

8. Should RUF's be based on new energy supplies or on the existing mix? If a new mix should be used, how can this be done? What mix should be used? What year should be the base year for the data?

9. Is marginal costing of fuels a viable alternative approach to accounting for conversion and delivery losses, as well as sociological factors?

IV.D Design Energy Budgets Selection.

IV.D.1 The Preliminary Ranges.

APPENDIX I of this document contains preliminary design energy budgets for a number of building classifications. As explained in Section V, these design energy budgets are based on the statistical analyses only, with no input from the economic studies, environmental impact analyses, or the regulatory analysis program, none of which had progressed sufficiently to contribute to the decision process.

It must be emphasized that: (a) this selection process should not be viewed as the only one which will be considered for the proposed and final design energy budgets; and (b) the entire selection exercise was done at this time solely for the purpose of providing the public with an idea of the concepts which may be included in the Standards. The preliminary design energy budgets displayed should be viewed only as indications of the relative ranges of values which might be possible.

There are a number of factors which support this position: (1) The original baseline data contained several anomalies, which are currently being investigated; (2) the energy for domestic hot water was not included in the baseline data; (3) the parametric model used as the baseline for the selection was in the process of being refined in order to provide statistically more accurate information; (4) both the building classifications and the climatic zones were being examined for possible further refinement; (5) the preliminary design energy budgets were limited to consideration of only the 20% to 50% range of the parametric baseline and the 80% level of the technical redesign; and (6) neither the economic nor the environmental analyses had progressed sufficiently to contribute to the selection decisions.

DOE is aware that the full ranges of design energy consumption for the original, parametric and redesign data bases must remain in consideration, because of the possible influences of the economic benefit/cost studies. Conceivably, it might prove financially costly to set the design energy budgets below the 50% level of the baseline, although

early indications predict that considerable energy savings can be effected with little or no increase in first costs. In addition, life-cycle cost evaluations could strongly favor more stringent design energy budgets, and such considerations could include both individual structures and the national economy.

IV.D.2 The Parametric Model.

The concept of using the parametric model as the baseline for the selection process is also in question. This model, as explained in APPENDIX II, took the 1661 nonresidential buildings of the Phase I data base and used them as a basis to project a design energy consumption distribution for the total new construction universe for these building classifications. Statistically, this appears to be an acceptable technique. DOE is interested in the public's reaction.

IV.D.3 Climate and Design Energy Consumption Ranges.

It should be noted that the 20% to 50% baseline ranges shown in the matrices in Section V.B.4.a(1) were selected from that part of each climatic zone which presented the worst-case weather conditions with which the designer had to deal. This was the area of each climatic zone which had the highest combination of heating degree-days and cooling degree-days. The implication of this decision was that the 20% or 30% levels shown in Section V.B.4.a(1) in some cases exceeded the design energy consumption levels of the average (50%) of the original survey of existing designs presented in the Phase I reports.

IV.D.4 The Single-Family Residences Methodology.

DOE is also interested in comments on the issue of the development of design energy budgets for single-family residential construction. Section V and APPENDIX I detail the preliminary procedure selected for this document.

The reasoning used was based on the nature of the construction sector concerned with residential buildings, a sector in which design teams with extensive technical expertise do not typically exist on individual projects. Because of this, the methodology proposed for commercial buildings was thought to be inappropriate and complex for single-family residential structures.

DOE went back to the prototype design effort, which used the HUD Minimum Property Standards for One and Two Family Dwellings (HUD/MPS) and the NAHB Thermal Performance Guidelines for One and Two Family Dwellings (NAHB/TPG), and examined these two guidelines and their relationship to the baseline data. The examination revealed that the NAHB/TPG apparently accounted for economic and fuel considerations that the HUD/MPS did not.

DOE then undertook to determine if a method could be devised which would utilize the NAHB/TPG as a basis for computing design energy budgets for single-family residential structures, a method which would produce acceptable energy conservation levels and would take into account source energy, social factors and other factors similar to those considered for commercial structures. The result of this investigation was the floating design energy budget methodology presented in APPENDIX I. With this

system, the builder in essence develops his own design energy budget by going to the NAHB/TPG, referring to the appropriate index, performing the necessary calculations, and then referring to the methodology in the preliminary format and converting to MBtu/sq. ft./yr.

By way of explanation, the NAHB/TPG is built around an index which: (1) expresses climatic severity in heating degree-days and cooling hours, indicating how much energy is theoretically expected to be used for heating and cooling; and (2) considers both the value of improved thermal integrity, expressed in energy savings, and the incremental costs of that increased integrity. In other words, the NAHB/TPG balances the costs of improvements against the value of the expected energy savings resulting from increased levels of insulation and glazing; i.e., a cost effectiveness procedure.

The NAHB/TPG user obtains a value from the index, refers to a graph on insulation, reads the levels of insulation that the shell components (walls, floors, ceilings) of his structure should have for his particular geographic location and fuel prices, and then refers to the information on windows and repeats the process. Thus, the amount of insulation and the type of windows installed depend on:

- local existing energy costs and expected increases in those costs (recommended by the NAHB/TPG to be obtained from the local utility);
- local climatic conditions, expressed in heating degree-days and cooling hours;
- local construction costs (incurred by the user); and
- assumptions about the appropriate discount rate and the payback period, assumed to be seven years.

Once the user has obtained the pertinent information regarding his structure in his geographic location, he then consults the preliminary format and performs the conversion to MBtu/sq. ft./yr. (described in APPENDIX I), and arrives at the design energy budget to which his structure must conform. He is then essentially "free" to redesign the structure, as long as a reevaluation of that design results in a design energy consumption that is not greater than the design energy budget he himself calculated.

It should be noted that the NAHB/TPG methodology is considered an algorithm, one that can be changed, depending on the results of the economic and environmental analyses, and on public comments regarding the procedure and several important facts and issues.

First, the NAHB/TPG addresses the thermal integrity of only the building shell components. It does not deal with the building as a system and it does not consider components other than those of the shell. This means that: (a) buildings could be designed in accordance with the NAHB/TPG and still use more energy than current buildings, such as a structure with a north-facing wall consisting entirely of glass; (b) energy savings due to the use of more efficient equipment, renewable resources, lower hot water temperatures, energy-conscious siting of the structure, color and other design options are not allowed for; (c) some passive solar designs may not be acceptable under the NAHB/TPG; and (d) increasing thermal resistance does not always result in energy conservation, as exemplified by the fact that increasing floor insulation in some southern locations increases, not decreases, energy use.

In addition, if energy prices are low and construction costs are high, or the climate is mild, the NAHB/TPG may not result in any energy savings.

Preliminary analyses indicate that, at the national level, the NAHB/TPG would only result in homes as energy efficient as the revised HUD/MPS. Preliminary analyses also indicate that the NAHB/TPG generally results in only a negligible change in current practice for walls, from R11 to R13; whereas, ceiling R factors go from R19 to R26, and floors from no insulation to R13. Finally, window materials and designs do not appear to change, but glass almost universally changes to double glazing.

Other issues related to the NAHB/TPG are as follows:

(1) What prices should be used in calculating the required building thermal integrity: average local prices, costs of new local energy supplies, or average costs of new national energy supplies?

(2) What is the appropriate discount rate?

(3) Is the use of the seven-year payback period effective, or would the life of the building or the mortgage be more appropriate (30 to 50 years)?

(4) How adequately do energy prices measure the value of energy use to the United States?

IV.D.5 Multifamily Low-Rise Residential Structures

The next area of specific concern to DOE involves the anomalies presented by multifamily low-rise residential structures. It is difficult to determine whether these buildings should be treated similar to single-family attached residential structures or high-rise structures (with only four floors or less). The anomaly occurs, evidentally, because some buildings are completely enclosed (thus resembling high-rise structures with only four floors), while others have open entrances and stairwells, (thus resembling single-family attached residences). It should also be noted that these structures were included in the residential group for the data collection and analyses of Phase I, but were then included in the commercial group for the technical redesigns of Phase II. Comments on this issue are invited.

IV.D.6 Design vs. Actual Building Energy Consumption.

DOE is also interested in comments relative to the relationship between estimated design energy consumption and actual energy consumption once the building is constructed and occupied. Estimates of projected energy use based on a building's design are considered to be good indicators of actual energy consumption; however, they may prove inaccurate. Several factors, beyond the designer's control, could contribute to this discrepancy: actual construction vs. design intentions; actual hours of operation, as compared to assumed operating profile; actual efficiency of operation vs. assumed efficiency; actual weather conditions compared to the historical conditions assumed for the design analysis; and the limitations of modeling techniques.

DOE feels that energy conserving features in the design should increase the potential for energy conservation during actual operation. In addition, carefully considered and designed control systems should enable a building to operate more efficiently and with less energy.

DOE will conduct a study of the effective relationship between design and actual energy consumption. In the meantime, DOE would appreciate comments on: the methodology for the study; the building types, operating characteristics and geographical locations that might be included; and the issue of assessing the economic and environmental impacts involved when the relationship between design and actual energy consumption is not definitive.

IV.D.7 Alternative Assumptions.

The last issue concerns the concept that the design energy budgets be based on actual buildings and on separate fuels. Alternative approaches are possible, and a number of them are discussed in Section IV.A.

IV.D.8 Conclusion.

The preceding discussions cover those issues of which DOE is aware with respect to the preliminary design energy budgets. DOE is seeking the public's comments, input and suggestions, not only with respect to the issues described, but also with respect to any other issues which the public feels are germane to this area of concern.

IV.E Evaluation Techniques Analyses.

A recent edition of the "Energy User News" (Vol. 3, No. 32, August 7, 1978) contained an article on energy-use simulators for buildings. The article explained many of the difficulties encountered by DOE in attempting to choose a model for calculating the design energy consumptions of the Phase I buildings. Many programs are still in development, while others are untested. Some only respond to one type of fuel, others include preset values for equipment capacities, and most vary with respect to one another in the area of building zone definitions and temperature change measurement techniques.

In addition, some programs are proprietary and others are in the public domain.

DOE is interested in comments and suggestions relative to these and other issues, as follows.

Should specific test methods be included in the Standards, or should the methodology recommended be more general? If specific, what test methods should be included? If general, how broad should they be?

What level of accuracy should be required of any method recommended? As a follow-on, how accurate should the method be with respect to actual energy consumption demonstrated by the building?

If a proprietary method is included, to what extent can that method's properties and operation be described without violating the laws regarding proprietary information?

What criteria should be used to define an acceptable evaluation technique? Should the Federal Government develop those criteria, or should this be done by professional architectural/engineering groups?

Finally, could the need for specific test methods in the Standards be satisfied by referring to "any recognized calculation procedure?" How would the "recognition" of a technique be determined or defined?

IV.F Updating Procedures Analysis.

As stated in Sections II.A, III.E and APPENDIX I the Standards are to be reviewed and updated. The issues related to this action are delineated as follows:

1. How often should the review and update be initiated?
2. On what bases should the update decision be made, after the results of the review are known?
3. What supporting programs, if any, should be conducted with each update? Should the same programs be used for all updates, or should the review process include an analysis of supporting programs required?
4. How much lead time should be allowed for the review, prior to a possible update?
5. What precisely should be reviewed? The design energy performance of current practice? The actual energy conservation resulting from enforcement of the Standards? Changes in technology which might make more stringent Standards plausible, even though the existing Standards are adequate with respect to energy conservation?
6. Should technical assistance be provided to States to assist in the updates?

In short, the issues related to updates are essentially the same as those related to the initial development and promulgation of the Standards. The public's comments are invited.

V. THE PRELIMINARY STANDARDS: DISCUSSION

V.A General Comments.

APPENDIX I of this document contains a Preliminary Standards Format. This format was developed for and included in this ANPR for the purpose of providing the public with substantive information on DOE's current thinking regarding the possible elements and structure of the Standards to be promulgated in 1979. The format is based on only one of several possible approaches which could be used in developing the Standards (see Section IV.A).

The following discussions are intended to explain the format, where explanation is considered necessary, so that the public can more effectively evaluate and comment on its contents.

There are several comments which bear emphasizing and repeating. First, the Standards will not include the background data and supporting information related to their development. These will be reserved for the Environmental Impact Statement, Economic Impact Statement, Regulatory Analysis, Phase I and II reports, and other supporting documents, as described in Section VI. These documents will be included in an official public docket and will be made available to the public (see Section VI).

Second, because this is an Advance Notice of Proposed Rulemaking, the format included should be considered only preliminary. For example, there are preliminary design energy budgets displayed in some of the matrices for certain building classifications. As explained in Section IV, these numbers are only indications of the possible ranges that are under investigation; they are not to be taken as the proposed values. They are based only on the statistical analyses, were selected from a consideration of only a limited portion of the parametric baseline (the 20% to 50% range) and the 80% level of the technical redesign, and are judgmental and subjective. In addition, the environmental and economic studies have not been completed, and the results of these two studies alone could and are expected to contribute to the selection of the proposed and final design energy budgets.

It should also be noted that the methodology used in the developmental program is not considered the only one acceptable. Section IV.C includes discussions on the problems encountered with that methodology, as well as possible alternatives for the proposed and final Standards.

V.B. Specific Comments.

V.B.1 Definitions.

The definitions included in the preliminary format are, for the most part, self-explanatory. However, it should be noted that the term "nonresidential building" does not appear. The term "commercial building" is used and includes no residential structures. (In the data collection and analyses of Phase I, multifamily high-rise residential structures were included in the nonresidential buildings group; in the technical redesigns of Phase II, both multifamily high-rise and multifamily low-rise residential structures were included in the nonresidential group.)

V.B.2 Building Classifications.

The building classifications displayed in the preliminary format are not precisely the same as those indicated in the Phase I data collection effort. They are more refined. The refining and redefinition process is still going on.

The bases for this ongoing effort are: (1) known anomalies resulting from the variety of buildings being included in a single classification, as in the assembly buildings and colleges or universities categories; (2) emerging implications that size may affect the design energy consumption in certain building classifications, such as mobile homes and possibly single-family structures; (3) overlapping classifications, such as grade overlaps in elementary vs. secondary schools, hospitals vs. clinics, fast food restaurants vs. full menu restaurants; and (4) difficulties of the present classification system to deal with certain types of buildings, such as enclosed shopping malls.

It should be recognized that, if the building classifications are amended or repartitioned, the data base associated with the current classifications will also require repartitioning.

V.B.3 Climatic Zones and Design Temperature Zones.

As discussed in Section III, there are two zone configurations used in the preliminary format. The first, depicted in Figure 1, is applicable to all building classifications except mobile homes. The second, shown in Figure 2, is applicable only to mobile homes. This second zone system was utilized for mobile homes because those structures could conceivably be built anywhere in the country for use anywhere else in the country. The specific zone system was chosen because it is used by HUD in its Mobile Home Construction and Safety Standards.

The method of defining the climatic zones is also in question, a the heating degree-days and cooling degree-days breakdown for each zc which differs from zone to zone. Also, the use of heating degree-days cooling degree-days as the basis for measurement is not the only met available, and other methods, or a modification of the existing one, cc produce different climatic zones.

A redefinition of the climatic zones would also necessit repartitioning the data base.

V.B.4 Design Energy Budgets.

The overall concept for the preliminary Standards format was select design energy consumption levels which could be technologic achievable, would be acceptable economically and environmentally, would accomplish a desirable level of conservation of nonrenewable ene and increase the use of renewable resources. Once these levels w selected, they would be viewed as the "unadjusted design energy budge i.e., the design energy budgets at the building line. Then, in order to m the design energy budgets source-energy related, each of these unadju design energy budgets would be multiplied by a RUF and a RIF (discusse Section III.B). The result would theoretically be a source-based de energy budget based in part on the design energy consumptions b achieved in buildings, in part on the economic and environmental fa pertinent to both energy and construction, and in part on the source-en and sociological considerations involved in supplying that energy.

Again, this entire approach is but one of many which could be used to develop the design energy budgets. Other approaches are discussed in Section IV.A.

The three steps followed were:

(a) Selection of the preliminary unadjusted design energy budgets.

(b) Selection of the RUF's and RIF's.

(c) Calculation of the preliminary design energy budgets.

V.B.4.a Selection of the Preliminary Unadjusted Design Energy Budgets.

In general, this process dealt with commercial and multifamily residential buildings first, then with single-family residential structures and finally with mobile homes. Within each of these groups, the procedure was first to examine the data available, then develop guidelines for the selection process, and finally reexamine the data using those guidelines and select the preliminary unadjusted design energy budgets. It should be noted that the only data available for this ANPR were from the statistical analyses, which were in themselves still preliminary. Because of this and because of the absence of economic and environmental information, the guidelines were necessarily judgmental and subjective. Therefore, the selections were considered to be only estimations, and should not be taken as the proposed or final design energy budgets to be promulgated in 1979.

(1) Nonresidential buildings.

After examining the statistical data available on all of the buildings included in this category, the following guidelines were decided upon:

1. Begin with small office buildings, since considerable information was already available on them, the spread of the 20% to 50% range of the baseline (see No.'s 4 and 5) was small, and the analysis appeared straightforward.
2. Use the same strategy in evaluating all commercial and multifamily residential building classifications, but deal with each classification individually.
3. Accept and use the seven climatic zones developed in Phase I.
4. Accept the parametric model of Phase II as a valid representation of the total new construction universe for commercial buildings for the time period involved. (See Section III.A and APPENDIX II for a discussion of the parametric model.)
5. Use the parametric model as the baseline in the preliminary design energy budget selection process.
6. Use the worst-case conditions in each zone as the design energy consumption levels of the parametric baseline, in order not to penalize building designs having to consider those conditions.
7. Consider only the 20% to 50% range of this baseline, because: (a) anything below the 20% level might mean an undue burden on the construction industry; and (b) it was felt that the unadjusted design energy budget should reflect a level that was at least as good as (i.e., as low as) the average (50%) design energy consumption level for the designs of buildings already being constructed.

8. Select the level of the preliminary unadjusted design energy budget by:

   a. Examining the spread between the upper end (i.e., the 50% level) and the lower end (i.e., the 20% level) of the baseline;

   b. Examining the 80% level of the technical redesigns (described in Section III.A and APPENDIX II) with respect to the baseline 20% to 50% range; and

   c. Examining the ASHRAE 90-75R and the HUD/MPS simulations, if applicable, with respect to the 20% to 50% range of the baseline.

The decision to start with small office buildings was based partly on the awareness that several years ago the General Services Administration (GSA) had established a design energy level for new Federal office buildings and that there was considerable information available on this program. When the statistical data on small office buildings were reexamined after the guidelines were developed, it was revealed that, for most climatic zones, the 30% level of the baseline closely approximated the level set by GSA. This set the stage for examining the 30% level of the baseline for other building classifications in the commercial and multifamily residential group.

The parametric model was used as the baseline, rather than the original data base of Phase I, because the parametric model was developed specifically to represent the total construction universe for new commercial buildings; whereas, the Phase I data represented only the actual buildings included in the sample.

Finally, the technical redesign was thought to represent what building designs could be made to do from an energy conservation standpoint. Therefore, a comparison of what the building designs actually did to what they could do was thought to be appropriate as a guide for this preliminary selection process. However, it should be noted that, at the time of the selection exercise, only the 80% level of the technical redesign was available and therefore only this level was included in the guidelines. The entire range of the technical redesign will be considered in any future design energy budget selection efforts.

The following paragraphs and matrices, presented in alphabetical order, provide the preliminary selection decisions and the data points considered. Note that the matrices also show the lowest levels of the technical redesigns. This information is included to provide the public with a better picture of the ranges of values which are being considered for the proposed and final Standards.

(a) Assembly Buildings: Although data were available, this classification was not evaluated at this time because it was decided that the variations in operating profiles and design energy consumptions of the many different types of buildings included in this classification required further examination for possible repartitioning.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	101	73	61	50	28	45	50
30% BASELINE	115	87	76	64	43	55	64
50% BASELINE	138	111	99	87	66	83	87
80% TECHNICAL REDESIGN	94	76	68	59	45	57	59
LOWEST TECHNICAL REDESIGN	44	32	36	53	*	16	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, §435.8(b)(1), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(b) Clinics: The 80% level of the technical redesign was chosen as the preliminary unadjusted design energy budget. The level chosen is higher than the 30% level of the baseline, indicating that there may be less room for improvement in this classification than in some others. This is supported by the tight clustering of the 20% to 50% range of the baseline.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	89	73	65	58	46	50	58
30% BASELINE	97	80	73	65	53	57	65
50% BASELINE	109	93	85	68	66	70	78
80% TECHNICAL REDESIGN	98	83	76	70	59	63	70
LOWEST TECHNICAL REDESIGN	30	56	37	48	19	*	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(2), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatit zone; the technical redesign data have not. (See Section IV.D.3.)

(c) Colleges or universities: The 30% level of the baseline was selected as the preliminary unadjusted design energy budget. This level would encourage lower life-cycle costs and reduce the tax dollar loads for publicly supported colleges and universities. Again, the cluster of the 20% to 50% range of the baseline is relatively tight, indicating that the 30% level would not be difficult to attain. Also, 30% of the new buildings constructed in this category should already be designed to this level.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	55	52	54	55	51	74	55
30% BASELINE	64	62	63	65	60	79	65
50% BASELINE	80	78	79	80	76	99	80
80% TECHNICAL REDESIGN	59	58	59	59	56	73	59
LOWEST TECHNICAL REDESIGN	NOT AVAILABLE						

At the time of selection of the reference figures in APPENDIX I, §435.8(b)(3), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(d) Hospitals: The 30% level of the baseline was selected as the preliminary unadjusted design energy budget. There appears to be considerable room for improvement in the designs for this building category, as indicated by both the wide spread in the baseline 20% to 50% range and the position of the 80% level of the technical redesigns relative to the baseline. In all but one zone, the latter falls below the 20% level of the baseline.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	109	120	131	142	142	207	142
30% BASELINE	138	150	160	171	171	225	171
50% BASELINE	186	197	208	219	219	284	219
80% TECHNICAL REDESIGN	111	117	124	130	130	169	130
LOWEST TECHNICAL REDESIGN	*	*	85	53	*	72	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, §435.8(b)(4), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(e) Hotels or motels: The 80% level of the technical redesign was selected as the preliminary unadjusted design energy budget. Based on the tight clustering of the 20% to 50% range of the baseline, and on the fact that the 80% level of the technical redesign is in all cases higher than the 30% level of the baseline, there appears to be less room for improvement in the designs for this building category than in some others.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	82	71	66	62	53	60	62
30% BASELINE	94	83	79	74	63	72	7-
50% BASELINE	115	104	99	94	85	93	94
80% TECHNICAL REDESIGN	96	87	83	79	71	78	79
LOWEST TECHNICAL REDESIGN	*	49	42	*	*	35	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(5), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(f) Industrial Buildings: This classification was not evaluated at this time because of the complex interrelationship between process and nonprocess energy and because insufficient data had been obtained to formulate design energy consumption distributions or conduct any of the redesign programs.

(SPACE RESERVED)

DESIGN ENERGY CONSUMPTION	CLIMATIC ZONE						
	1	2	3	4	5	6	-
20% BASELINE							
30% BASELINE							
50% BASELINE							
80% TECHNICAL REDESIGN							
LOWEST TECHNICAL REDESIGN							

At the time of selection of the reference figures in APPENDIX I, §435.8(b)(6), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(g) Mercantile Buildings: The 30% level of the baseline was selected as the preliminary unadjusted design energy budget. This should encourage desirable energy conservation without being as restrictive as the 80% level of the technical redesigns, which fell below the 20% level of the baseline. Also, 30% of the new buildings constructed in this category should already be designed to this level.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	87	75	71	67	58	68	67
30% BASELINE	96	85	81	76	67	78	76
50% BASELINE	112	101	97	92	83	94	92
80% TECHNICAL REDESIGN	78	70	67	64	56	65	64
LOWEST TECHNICAL REDESIGN	*	50	39	33	*	38	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(7), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(h) Multifamily High-Rise Residential Buildings: The 80% level of the technical redesign was chosen as the preliminary unadjusted design energy budget. The reasons were the same as those expressed for hotels.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	40	36	35	33	30	35	33
30% BASELINE	48	44	43	41	38	43	41
50% BASELINE	62	58	56	55	51	56	55
80% TECHNICAL REDESIGN	56	52	50	49	46	50	49
LOWEST TECHNICAL REDESIGN	34	*	*	17	*	*	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(9), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(i) Multifamily Low-Rise Residential Structures: Preliminary design energy budgets were not selected for this classification at this time because the data and analyses require further study. These structures were included in the residential sector for the Phase I effort, but in the nonresidential redesign programs in the Phase II effort. This caused inconsistencies in the comparisons between the baseline data and the redesign data. Also, the baseline data revealed that these structures behaved like high-rise structures in some ways and like single-family attached residential structures in other ways. Therefore, the base data are not included in this ANPR, pending further study.

(SPACE RESERVED)

DESIGN ENERGY CONSUMPTION	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE							
80% BASELINE							
50% BASELINE							
80% TECHNICAL REDESIGN							
LOWEST TECHNICAL REDESIGN							

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(10), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(j) Nursing Homes: The 30% level of the baseline was chosen as the preliminary unadjusted design energy budget. The reasoning was the same as that expressed for hospitals.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	104	85	80	74	58	85	74
30% BASELINE	120	102	96	90	74	102	90
50% BASELINE	148	130	120	118	102	130	118
80% TECHNICAL REDESIGN	90	79	73	71	62	79	71
LOWEST TECHNICAL REDESIGN	21	43	41	34	24	52	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(11), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(k) Offices/Large (greater than 50,000 sq. ft.): The 30% level of the baseline was chosen as the preliminary unadjusted design energy budget. This level is relatively close to, though higher than, the level set and used by GSA for new Federal office buildings. The level chosen takes into consideration the fact that current technology reflects higher design energy usage for large office buildings than for small ones. Here, too, the 20% to 50% range of the baseline is very tight, implying that the same argument applies as for small office buildings. Finally, 30% of the new buildings constructed in this classification should already be designed to this design energy consumption level.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	55	53	53	53	51	57	53
30% BASELINE	60	58	58	58	56	62	58
50% BASELINE	68	66	66	66	64	70	66
80% TECHNICAL REDESIGN	49	48	48	48	46	51	48
LOWEST TECHNICAL REDESIGN	29	38	26	31	*	42	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(12), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(1) Offices/Small (less than or equal to 50,000 sq. ft.): The 30% level of the baseline was chosen as the preliminary unadjusted design energy budget. In all zones, this level closely approximates the level established and used by GSA for new Federal office buildings. Also, 30% of the new buildings constructed in this classification should already be designed to this level. Finally, the spread of the 20% to 50% range of the baseline is relatively small, implying that it should not be difficult for more building designs to be brought to this 30% level.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	50	49	49	47	47	54	47
30% BASELINE	56	55	55	53	53	60	53
50% BASELINE	66	64	64	62	62	70	64
80% TECHNICAL REDESIGN	49	47	47	46	46	52	47
LOWEST TECHNICAL REDESIGN	29	45	20	*	*	39	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(13), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(m) Restaurants/Fast Food: Although data were available, this classification was not evaluated at this time because further analyses were needed on the high ratio of design process energy to overall design energy consumption, as well as the complex interrelationships between the two.

DESIGN ENERGY CONSUMPTION (METU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	218	173	156	133	101	116	133
30% BASELINE	243	199	179	159	126	141	159
50% BASELINE	285	241	221	201	168	183	201
80% TECHNICAL REDESIGN	204	173	158	144	120	131	144
LOWEST TECHNICAL REDESIGN	*	64	81	78	59	120	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(14), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(n) Restaurants/Full Menu/Other: Again, although data were available, this classification was not evaluated at this time because further analyses were needed on the high ratio of design process energy to overall design energy consumption, as well as the complex interrelationships between the two.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	106	99	98	97	90	109	97
30% BASELINE	112	114	113	112	105	124	112
50% BASELINE	145	130	137	136	129	148	136
80% TECHNICAL REDESIGN	124	112	118	117	111	127	117
LOWEST TECHNICAL REDESIGN	81	42	64	74	*	*	*

* - Not available.

At the time of selection of the reference figures i APPENDIX I, § 435.8(b)(15), the only information available wa the 20% to 50% levels of the parametric baseline and the 80% level o the technical redesign. Also shown in the previous matrix is th maximum performance level of the technical redesign. The propose and final design energy budgets will consider the full range show and will be based on both the statistical and impact analyses, a described in Section III. Note that the baseline data and technica redesign data shown above are not strictly comparable. The baselin data have been adjusted to reflect the most severe climate condition in each climatic zone; the technical redesign data have not. (Se Section IV.D.3.)

(o) Schools/Elementary: The 30% level of the baseline was selected as the preliminary unadjusted design energy budget. The reasoning was the same as that indicated for colleges or universities.

(NOTE: Additional studies are being conducted to determine why elementary schools have apparently higher design energy consumptions than secondary schools, which in turn are apparently higher than colleges or universities.)

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	91	72	63	54	41	39	54
30% BASELINE	97	79	70	61	48	46	61
50% BASELINE	109	90	81	72	59	57	72
80% TECHNICAL REDESIGN	72	59	53	48	39	38	48
LOWEST TECHNICAL REDESIGN	49	32	34	18	14	31	22

At the time of selection of the reference figures in APPENDIX I, §435.8(b)(16), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(p) Schools/Secondary: The 30% level of the baseline was selected as the preliminary unadjusted design energy budget. The reasoning was the same as that indicated for elementary schools and colleges or universities.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	80	62	53	44	31	32	44
30% BASELINE	84	66	57	48	36	36	48
50% BASELINE	92	73	65	56	43	43	56
80% TECHNICAL REDESIGN	68	54	48	42	32	32	42
LOWEST TECHNICAL REDESIGN	35	47	35	*	*	30	38

* - Not available.

At the time of selection of the reference figures in APPENDIX I, § 435.8(b)(17), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(q) Warehouses: Although data were available, this classification was not evaluated at this time because of unexplained high design energy consumptions requiring further investigation.

DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	CLIMATIC ZONE						
	1	2	3	4	5	6	7
20% BASELINE	84	61	51	41	25	28	41
30% BASELINE	92	70	59	49	33	36	49
50% BASELINE	105	83	72	62	46	49	62
80% TECHNICAL REDESIGN	79	62	54	46	34	37	46
LOWEST TECHNICAL REDESIGN	21	20	28	23	9	20	*

* - Not available.

At the time of selection of the reference figures in APPENDIX I, §435.8(b)(20), the only information available was the 20% to 50% levels of the parametric baseline and the 80% level of the technical redesign. Also shown in the previous matrix is the maximum performance level of the technical redesign. The proposed and final design energy budgets will consider the full range shown and will be based on both the statistical and impact analyses, as described in Section III. Note that the baseline data and technical redesign data shown above are not strictly comparable. The baseline data have been adjusted to reflect the most severe climate conditions in each climatic zone; the technical redesign data have not. (See Section IV.D.3.)

(2) Single-Family Residential Structures.

Following the same pattern of reasoning that was used for commercial and multifamily residential structures, guidelines were developed for single-family detached and attached residential structures. These guidelines were as follows:

1. Use the seven climatic zones developed in Phase I.
2. Use the NAHB/TPG, as they appear to account for fuel, size and economic factors that the HUD/MPS apparently do not.
3. Base the preliminary design energy budgets on a method developed around the NHB/TPG.

The initial review of the data base, along with the professional knowledge of the program team regarding residential construction practices, led to the belief that an approach such as that suggested for the commercial sector might be inappropriate for the residential sector. As explained in Section IV.D, the program team attempted to develop, at least on a preliminary basis, a methodology which would be more appropriate. Since the HUD/MPS and the NAHB/TPG had been used in the Phase II prototype design programs for single-family residential structures, these two guidelines were reviewed to determine if a technique could be developed around one, or perhaps both, of them.

This review resulted in the conclusion that, since the NAHB/TPG accounted for the apparent effects of size, fuel and economic factors that the HUD/MPS apparently did not, the NAHB/TPG would form a better base for the preliminary design energy budget selection. In effect, the NAHB/TPG eliminated the need for RUF's and possibly even RIF's because of the way in which the guidelines are constructed (see Section IV.D for more complete discussion).

Therefore, a methodology was developed for utilizing the NAHB/TPG to arrive at a site-specific design energy budget, in effect a floating budget developed by the builder. The process is detailed in Section IV.D and in Appendix I. The matrices included in this discussion delineate the data available during the preliminary design energy budget selection exercise.

AVERAGE DESIGN ENERGY CONSUMPTION FOR SINGLE-FAMILY ATTACHED RESIDENTIAL STRUCTURES

(MBTU/SQ. FT./YR)

DESIGN GUIDE	ZONE / FUEL	1			2			3			4	
		GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL
AS BUILT		76	97	27	62	60	23	59	55	25	45	N/A
NAHB/TPG		61	69	17	58	36	17	60	43	17	47	N/A
HUD/MPS		52	74	18	46	41	17	45	43	17	45	N/A

*N/A - Fuel not reported used in that climatic zone.

DESIGN GUIDE	ZONE / FUEL	5			6			7		
		GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL	ELEC.
AS BUILT		28	N/A	N/A	34	N/A	21	42	N/A	27
NAHB/TPG		27	N/A	N/A	36	N/A	20	46	N/A	18
HUD/MPS		27	N/A	N/A	36	N/A	18	45	N/A	20

AVERAGE DESIGN ENERGY CONSUMPTION FOR SINGLE-FAMILY DETACHED RESIDENTIAL STRUCTURES

(MBTU/SQ. FT./YR)

DESIGN GUIDE	ZONE / FUEL	1			2			3			4		
		GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL	ELE
AS BUILT		106	109	48	92	90	41	93	99	38	74	64	35
NAHB/TPG		110	72	32	106	62	28	100	74	31	81	55	29
HUD/MPS		88	91	39	79	71	33	78	76	29	72	65	31

*N/A - Fuel not reported used in that climatic zone.

DESIGN GUIDE	ZONE / FUEL	5			6			7		
		GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL	ELEC.
AS BUILT		46	N/A	33	50	40	32	71	N/A	41
NAHB/TPG		50	N/A	21	55	43	29	79	N/A	29
HUD/MPS		47	N/A	15	51	39	29	73	N/A	33

(3) Mobile Homes.

The guidelines developed for mobile homes were:

1. Use the three design temperature zones in the HUD Mobile Home Construction and Safety Standards.
2. Accept the use of four nominal sizes to display the design energy budgets.
3. Accept the necessity of displaying the design energy budgets by fuel type.

(NOTE: The electricity category includes electric heat pumps, electric furnaces, and electric baseboard heat.)

4. Acknowledge that the industry is already designing to a standard; i.e., the HUD standards.
5. Use the design energy consumption levels of the two redesigns, MTFD-I and MTFD-II (see Section III.A and APPENDIX II), as guidelines.

These guidelines were in part influenced by the existing standards, the HUD Mobile Home Construction and Safety Standards, to which all mobile homes are already being constructed. Therefore, it was decided to utilize some of the concepts of these standards; i.e., the design temperature zones and the use of size and fuel type. Then, in a manner similar to that used for commercial structures, the current practice was compared to the technical redesigns. However, unlike the program for commercial structures, there were two technical redesigns for mobile homes, the second more extensive than the first and resulting in greater energy savings.

The discussions that ensued revolved around the economic effects of the two redesigns. However, those discussions were curtailed because sufficient details were not available regarding the contents of each technical redesign. Therefore, the decision was made not to select preliminary design energy budgets until more substantive decisions could be made regarding the relative economic impacts of the two redesigns.

The matrix presented shows the various data points that were available during the discussions.

AVERAGE DESIGN ENERGY CONSUMPTION FOR MOBILE HOMES
(MBTU/SQ. FT./YR)

NOMINAL SIZE (FT.)	ZONE	1			2			3		
	FUEL	GAS	OIL	ELEC.	GAS	OIL	ELEC.	GAS	OIL	ELEC
12 x 60	MTFD I	105	113	63	112	120	62	144	156	71
	MTFD II	59	63	33	87	94	47	123	133	61
14 x 70	MTFD I	95	103	56	101	109	55	131	142	65
	MTFD II	52	56	29	78	84	41	111	120	55
24 x 60	MTFD I	82	89	49	82	88	45	106	115	53
	MTFD II	43	47	25	64	69	34	90	97	44
28 x 70	MTFD I	70	76	42	72	78	39	94	102	47
	MTFD II	39	42	22	58	63	31	82	87	41

V.B.4.b Selection of the RUF's and RIF's.

As explained in the beginning of Section V.B, DOE felt that the preliminary design energy budgets should be source-energy related and reflect sociological considerations, and that the use of RUF's and RIF's was one way of incorporating the necessary adjustments. The information available on RIF's, however, was insufficient to permit their inclusion in this document; therefore, for the purposes of this document only, RIF's are assumed to be constant and equal to one.

The RUF analyses, on the other hand, had progressed sufficiently to permit the calculation of national average RUF's based on three fuels: gas, oil and electricity.

Fuel	National Average RUF
Gas	1.11
Oil	1.16
Electricity	3.04

National average RUF's may not be as meaningful as regional RUF's might be to regional (i.e., climatic zone) unadjusted design energy budgets, but they do allow some adjustment to be made toward demonstrating source-energy related design energy budgets. Also, the approach developed for incorporating RUF's into the preliminary design energy budgets is but one of many; Section IV.A discusses some of the other possibilities.

Because the unadjusted design energy budgets were expressed in terms of climatic zone but not in terms of fuels, it was decided to derive RUF's expressed by climatic zone and not by fuel. These RUF's were called "combined RUF's" because of the way they were developed and they were based on the national average RUF's calculated as explained in Section III.A.2.

First, DOE returned to the original data base of Phase I, where the actual building designs were available, already separated by building classification and climatic zone. For each actual building in each classification and climatic zone, estimates were made of the amounts and kinds of each fuel attributable to heating, cooling, fans and lights. For example, in a large office building located in climatic zone 1, the design energy consumption might have broken down as 12,000 Btu/sq. ft./yr of gas for heating, 4,000 Btu/sq. ft./yr of gas for cooling, 1,000 Btu/sq. ft./yr of electricity for fans and 11,000 Btu/sq. ft./yr of electricity for lights.

Then, in each climatic zone, the values for each fuel for all the buildings in a single classification were added together. In the example, the total for all the large office buildings in climatic zone 1 might have been: 31,980 Btu/sq. ft./yr of gas for heating; 10,940 Btu/sq. ft./yr of gas for cooling, 9,920 Btu/sq. ft./yr of electricity for fans, and 29,150 Btu/sq. ft./yr of electricity for lights.

Then, each total for each fuel was multiplied by the national average RUF for that fuel.

The resulting calculations, using the example, are as follows:

National Average RUF for Fuel Indicated	x	Design Energy Consumption (MBtu/sq. ft./yr)	=	Source-Energy Related Design Energy Consumption (MBtu/sq. ft./yr)
1.11 (gas)		31.98		35.50
1.11 (gas)		10.94		12.14
3.04 (electricity)		9.92		30.16
3.04 (electricity)		29.15		88.82
TOTALS		81.99		166.52

The final step was to divide the total source-energy related design energy consumption (column 3) by the total design energy consumption (column 2), and the result was termed the "combined RUF." For the example shown, the combined RUF would be 2.04.

This technique is based on real buildings and on the fuel mixes they represent, and it also uses calculated quantities based on nationally known figures; i.e., the national average RUF's. However, the entire process inherently assumes that the fuel mixes demonstrated by the original buildings will continue to be the fuel mixes used in the future, and this may not be valid. Additional discussion concerning the RUF concept, the related issues and the combined RUF, are contained in Sections III.B, IV.A and IV.C.

The matrix included in this discussion shows the combined RUF's developed for the various building classifications in the individual climatic zones, using the approach described.

COMBINED RUF'S

BUILDING CLASSIFICATIONS	CLIMATIC ZONES						
	1	2	3	4	5	6	7
CLINICS	2.4	2.4	2.6	2.7	2.8	3.0	2.8
COLLEGES OR UNIVERSITIES	2.1	2.0	2.6	2.5	2.5	2.5	2.2
HOSPITALS	2.5	2.5	2.4	2.1	2.3	2.3	2.4
HOTELS OR MOTELS	2.5	2.5	2.8	2.4	2.6	2.9	2.9
MERCANTILE BUILDINGS	2.6	2.5	2.8	2.8	3.0	3.0	3.0
MULTIFAMILY HIGH-RISE RESIDENTIAL BLDGS	2.0	2.1	2.2	2.8	2.6	3.0	3.0
NURSING HOMES	2.5	2.5	2.8	2.4	2.6	2.9	2.9
OFFICES/LARGE	2.6	2.5	2.7	2.8	2.7	3.0	2.8
OFFICES/SMALL	2.6	2.5	2.7	2.8	2.7	3.0	2.8
SCHOOLS/ELEMENTARY	2.1	2.5	2.6	2.6	2.7	2.9	2.5
SCHOOLS/SECONDARY	1.9	2.2	2.2	2.7	2.7	2.6	2.6

(NOTE: Combined RUF's are not shown for five commercial building classifications and four residential building classifications because preliminary design energy budgets were not selected for them. The classifications referred to are: assembly buildings, industrial buildings, mobile homes, multifamily low-rise residential buildings, fast food restaurants, full menu restaurants, and single-family attached and detached residential structures.)

V.B.4.c Calculation of the Preliminary Design Energy Budgets.

The third and final step in the overall process described in Section V.B was to calculate the preliminary design energy budgets, using the results of the first two steps. This procedure was relatively straightforward, consisting of multiplying the unadjusted design energy budget for a given building classification and climatic zone by the combined RUF for that same building classification and climatic zone. The results are displayed in the matrices included in APPENDIX I.

VI. SUPPORTING DOCUMENTATION.

VI.A The Docket.

An extensive docket is being compiled. This docket will be available in the DOE Freedom of Information Reading Room, and certain items may be obtained through other Federal Government sources, as explained in Section VI.B.

The basic information to be included in the docket is as follows:

1. All public contact or participation, including verbal and written correspondence, minutes of meetings, transcripts, etc.
2. A digest of all comments received.
3. Relevant Congressional comments.
4. Background documents, including:
   a. Building codes of the major code-promulgating bodies.
   b. Existing or proposed Federal controls, guidelines, and standards to be affected by or to co-regulate with the Standards.
   c. Existing or proposed building energy efficiency guidelines or standards developed by consumer or professional trade groups.
   d. State building energy efficiency guidelines or standards, proposed or promulgated.
   e. The contractual agreements related to the Standards development program.

f. All technical reports on or contributing to the development of the Standards, including reports from subcontractors or consultants to other subcontractors or consultants working on the development program.

g. Existing methodologies for assessing the design energy performance resulting from existing codes.

5. Legislative history of Title III of ECPA.

6. Any other technical/administrative support documents affecting the development of the Standards, and a digest of these documents.

7. A projected schedule of public meetings or participation in the development program.

8. A schedule for contact with senior liaison officials of other Federal agencies or associated entities.

Of necessity, the docket will be continually expanded as the program progresses. Public comments and response to this ANPR, to the proposed Standards, and even to the final Standards, will become a part of the first item in the list. In addition, as more studies are conducted and/or completed, the reports and supporting information relative to those studies will be included. Finally, as the Standards are updated, the docket will be continued to include all of the supporting documentation relative to those updates.

VI.B Obtaining Docket Material.

The following Phase I reports may now be obtained through the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia, 22151:

1. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, FINAL REPORT, January 12, 1978, HUD-0000-189 ($6.50) (includes the EXECUTIVE SUMMARY).

2. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, TASK REPORT, Climatic Classification, January 30, 1978, HUD-0000-190 ($4.50).

3. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, TASK REPORT, Data Collection, January 12, 1978, HUD-0000-191 ($4.50).

4. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, TASK REPORT, Residential Data Collection and Analysis, January 12, 1978, HUD-0000-192 ($6.50).

5. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, TASK REPORT, Data Analysis, January 30, 1978, HUD-0000-193 ($9.25).

6. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, TASK REPORT, Building Classification, January 12, 1978, HUD-0000-194 ($7.25).

7. PHASE ONE/BASE DATA for the development of ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS, TASK REPORT, Sample Design, January 12, 1978, HUD-0000-195 ($6.50).

Also, the NAHB Thermal Performance Guidelines for One and Two Family Dwellings may be obtained by addressing orders to the Publications Department, National Association of Home Builders, 15th and M Streets, N. W., Washington, D. C. 20005 ($3.00).

As the remaining items in the docket become formally available, information on the method of obtaining such material will be provided to the public.

VII. COMMENTS RECEIVED TO DATE.

A number of requests were received for information on various aspects of the program, including: the status of the program, procedures for adopting the Standards, the impact of the Standards on small buildings such as log homes, data on energy performance baselines, the Phase I reports, etc.

Several offers were also received to provide information to the program, including one to provide building characteristics, energy use dynamics and other industry data for the development of a model code, and another offering to provide data on actual energy consumption on buildings already constructed. On group representing the hotel/model industry met with DOE and discussed the ranges of actual energy consumption in buildings in this classification. The group also emphasized the fact that most hotels are complex organisms and that a single classification may prove unwieldy. Another group representing the restaurant industry met with DOE to discuss the group's desire to measure actual energy consumption of different types of restaurants in different geographical areas. This is a special concern of DOE, because of the problems with process energy considerations in the two restaurant building classifications.

One individual provided a document to HUD on the problems associated with prescriptive standards, and simultaneously urged that cost-effectiveness be included as one test for the Standards.

The American Gas Association expressed concern over the possibility of the Standards only measuring energy at the building line, rather than taking into account source energy considerations. Included in

the argument was the statement that electricity wastes most of its energy before the building line, where gas and oil are more inefficient within the perimeter of the building structure.

An official of the State of Arizona submitted commentary on that State's attempts to develop criteria and methodologies for drawing rational energy use budgets or energy performance standards for new buildings. And a Massachusetts official submitted information on the energy conservation code standards and administration provisions in Amherst and in the State of Massachusetts.

Another individual expressed an interest in the hours of operation related to the Btu's consumed and in the items of energy consumption included in those figures.

Finally, information was requested on the utilization of the Model Code in the Standards.

DOE is pleased with the awareness of the program demonstrated by the public and "affected groups." DOE also feels that the issues, comments and suggestions indicated have been addressed in this ANPR.

VIII. COMMENT PROCEDURES.

Interested persons are invited to participate in the public meetings by submitting, to the address indicated, data, views or arguments with respect to the subjects set forth in this notice.

Comments should be identified on the outside of the envelope, and on documents submitted to DOE, with the designation, "Building Energy Performance Standards." Fifteen copies should be submitted.

Any information or data considered to be confidential by the person furnishing it must be so identified and one copy submitted in writing. DOE reserves the right to determine the confidential status of the information or data and to treat it according to that determination.

IX. ORAL PRESENTATION; CONDUCT OF MEETINGS.

Any person who has an interest in this proceeding, or who is a representative of a group of persons having an interest, may make a written request for an opportunity to make an oral presentation. Such requests should be labeled both on the document and on the envelope, "Building Energy Performance Standards," and should be sent to the address indicated for the appropriate meeting at the beginning of this notice, by the time specified.

The person making the request should briefly describe the interest concerned, if appropriate, state why he or she is a proper representative of the group that has an interest, and give a phone number where he or she may be contacted.

DOE reserves the right to select the persons to be heard at these meetings, to schedule the respective presentations, and to establish the procedures governing the conduct of the meetings. The length of each presentation may be limited, due to the number of persons requesting to be heard. If time permits, the official conducting the meeting may, at his or her discretion, accept additional comments or questions from those attending the meeting.

A DOE official will be designated to preside at the meeting. These will not be judicial or evidentiary-type hearings. Questions may be asked only by those conducting the meetings, except during those periods when comments are requested from the floor. Any further procedural rules needed for the proper conduct of the meetings will be announced by the presiding officer.

Transcripts of the meetings will be made, and the entire record of the meetings, including the transcript but excluding any material deemed by DOE to be confidential as set forth in Section VIII, will be retained by DOE and made available for inspection at the Freedom of Information Office in the Forrestal Building, Independence Avenue and L'Enfant Plaza, S. W., Washington, D. C., between the hours of 8:00 a.m. and 4:30 p.m., Monday through Friday. Any person may purchase a copy of the transcript from the transcribing reporter.

Issued in Washington, D. C., on November 16, 1978.

Omi Walden
Assistant Secretary
Conservation and Solar Applications

APPENDIX I

PRELIMINARY STANDARDS FORMAT

Subchapter D, Chapter II of Title 10, Code of Federal Regulation is amended by establishing Part 435 as follows:

PART 435 - ENERGY PERFORMANCE STANDARDS FOR NEW BUILDINGS

Sec.

435.1 Purpose and scope.

435.2 Definitions.

435.3 Use of energy performance standards for new buildings.

435.4 Compliance.

435.5 Elements of an energy performance standard.

435.6 Building classifications.

435.7 Climatic zones and design temperature zones.

435.8 Design energy budgets.

435.9 Evaluation technique.

AUTHORITY: Energy Conservation Standards for New Buildings Act of 1976, enacted as Title III of the Energy Conservation and Production Act, Pub. L. 94-385, 90 Stat. 1144-1150, 42 U.S.C. 6831-6840; Department of Energy Organization Act, Pub. L. 95-91, 91 Stat. 965 et seq., 42 U.S.C. 7101 et seq.; E.O. 12009, 42 F.R. 4626F; E.O. 12044, 43 F.R. 12660.

435.1 Purpose and Scope.

This part establishes energy performance standards for new residential and commercial buildings, standards which are intended to achieve the maximum practicable improvements in energy efficiency and increases in the use of nondepletable sources of energy. This part also establishes evaluation techniques to determine whether or not a building design is in compliance with the energy performance standards for new buildings.

435.2 Definitions.

For the purposes of this part,

(a) "Adjusted design energy consumption" means the calculated design energy consumption of a building design, multiplied by the applicable RUF and RIF.

(b) "ASHRAE" means the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

(c) "British thermal unit" means the amount of heat required to raise the temperature of 1 lb. of water by 1° F at or near 39.2° F.

(d) "Btu" means British thermal unit.

(e) "Btu/sq. ft./yr" means Btu per gross square foot per year.

(f) "Building" means any structure to be constructed which includes provision for a heating or cooling system or both, or for a hot water system.

(g) "Building code" means (1) a legal instrument which is in effect in a State or unit of general purpose local government,

the provisions of which must be adhered to if a building is to be considered in conformance with the law and suitable for occupancy and use, or (2) a law, regulation or other construction control mechanism which provides for the application of the energy performance standards for new buildings.

(h) "Building design" means the architectural plans and specifications for a new building.

(i) "Building standard" means a standard which applies to a building rather than its component parts.

(j) "Climatic zone" means an area across the country which reflects similar climatic conditions as established by heating and cooling degree-days.

(k) "Commercial building" means any building other than a residential building, including any building developed for industrial or public purposes.

(l) "Cooling degree-day" is similar to heating degree-day, except that it relates to the requirement for space cooling.

(m) "Design energy budget" means the maximum allowable adjusted design energy consumption for a building design, expressed as Btu/sq. ft./yr.

(n) "Design energy consumption" means the calculated energy consumption for a building design, expressed as Btu/sq. ft./yr, not multiplied by the applicable RUF and RIF, excluding process energy requirements.

(o) "Design temperature zone" means an area across the country reflecting similar conditions appropriate to the construction of mobile homes.

(p) "DOE" means the U. S. Department of Energy.

(q) "Federal agency" means any department, agency, corporation, or other entity or instrumentality of the executive branch of the Federal Government, including the United States Postal Service, the Federal National Mortgage Association, and the Federal Home Loan Mortgage Corporation.

(r) "Federal building" means any building to be constructed by, or for the use of, any Federal agency which is not legally subject to State or local building codes or similar requirements.

(s) "Heating degree-day" means the space heating requirement for a given day, which varies directly with the difference between 65° F and the average of the extreme temperatures occurring on that day, expressed in Fahrenheit degrees. By definition, the number of heating degree-days associated with that day is equal to this numerical difference in temperature.

(t) "MBtu" means thousands of British thermal units.

(u) "MBtu/sq. ft./yr" means MBtu per gross square foot per year.

(v) "NAHB" means the National Association of Home Builders.

(w) "NAHB Thermal Performance Guidelines" means the NAHB Thermal Performance Guidelines for One and Two Family Dwellings, 1977, NAHB Publication Number 560.02.

(x) "New building" means any building for which the design has not been approved for construction by the appropriate State or local government authority as of 12:01 a.m. on the date that these energy performance standards for new buildings become effective.

(y) "Process energy" means that energy which is required to do work or produce a product, including the energy to operate appliances, business equipment and production machinery.

(z) "Residential building" means any structure which is constructed and developed for residential occupancy.

(aa) "Resource impact factor" means a multiplier applied to fuel and energy resources required by a building project, to permit a quantitative evaluation of the effect on those resources resulting from the selection of on-site fuel and energy forms, giving consideration to fuel availability, as well as to social, economic, environmental and national interest issues.

(bb) "Resource utilization factor" means a multiplier applied to the quantity of fuel or energy delivered to a building site, which provides a quantitative estimate of the energy resources consumed in providing that fuel or energy, accounting for the burden of processing, refining, transporting, converting and delivering fuel or energy from the point of extraction to the building site.

(cc) "RIF" means resource impact factor.

(dd) "RUF" means resource utilization factor.

(ee) "State" means any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, and any territory or possession of the United States.

(ff) "Unit of general purpose local government" means any city, county, town, municipality, or other political subdivision of a State, or any combination thereof, which has a building code or similar authority over a particular geographic area.

435.3 Use of energy performance standards for new buildings.

(a) The Secretary of the Department of Housing and Urban Development will:

(1) use the provisions of this part in a determination of the accuracy of a certification of a State that:

(A) a unit of general purpose local government has adopted and is implementing a building code which meets or exceeds the requirements of the energy performance standards, for new buildings; or,

(B) the State has adopted and is implementing a building code which provides for the effective application of the energy performance standards to new buildings; and

(2) require that the energy performance standards for new buildings shall be used by a State or unit of general purpose local government in a determination of whether the building design of a new building is in compliance with applicable performance standards.

(b) The head of each Federal agency responsible for the construction of any new Federal building will adopt such procedures as may be necessary to assure that the designs for any such construction meet or exceed the energy performance standards for new buildings.

§ 435.4 Compliance.

The building design of a new building shall comply with the energy performance standard for its building classification if the adjusted design energy consumption, calculated in accordance with §435.9 (a) and (b) does not exceed the design energy budget determined in accordance with §435.8.

§ 435.5 Elements of an energy performance standard.

(a) An energy performance standard consists of:

(1) a design energy budget, as provided in §435.8; and,

(2) the evaluation techniques prescribed in §435.9(b), which shall be used to estimate the adjusted design energy consumption.

(b) A design energy budget shall be identified for the building design of a new building in relation to:

(1) the building classification of the design, as established by §435.6; and,

(2) the climatic or design temperature zone for geographic location of the new building, as established by §435.7.

(c) The design energy budget for a building design which is limited to a single building classification, in accordance with § 435.6, shall be the design energy budget for that building classification, as provided in §435.8, for the appropriate climatic or design temperature zone, identifed by geographic location in accordance with §435.7.

(d) The design energy budget of a building design which is not limited to a single building classification, in accordance with § 435.6, shall be the sum of the design energy budgets for all applicable building classifications, as provided in §435.8, for the appropriate climatic or design temperature zone, identified by geographic location in accordance with §435.7, calculated by using the following equation:

$$\frac{(DEB_a)(A_a) + (DEB_b)(A_b) + \ldots + (DEB_n)(A_n)}{(A_a) + (A_b) + \ldots + (A_n)} = DEB_B$$

where, DEB_a = design energy budget for single-use classification "a"

A_a = area, in square feet, for single-use classification "a"

DEB_B = design energy budget for entire building design

(NOTE: The above is applicable to this Preliminary Standards Format only and is subject to change in accordance with the methodology utilized for the proposed and final Standards.)

435.6 Building classifications.

To calculate the design energy consumption or identify the design energy budget for a building design, the following definitions of building classifications shall be used:

(a) "Assembly building" means a structure or space used primarily for the gathering of 50 or more persons for civic, political, religious, social, recreational or entertainment purposes.

(b) "Clinic" means a structure or space used for out-patient treatment where the ill or injured receive medical, surgical or psychiatric diagnosis and treatment.

(c) "College or university" means a structure or space used for educational purposes for post-secondary school studies, requiring for admission a high-school diploma or its equivalent.

(d) "Hospital" means a structure or space for in-patient treatment where the ill or injured receive medical, surgical or psychiatric diagnosis and treatment.

(e) "Hotel or motel" means a structure or space used for short-term lodging, for which housekeeping services are provided, and provisions for meals, recreation, exhibitions and entertainment are sometimes available.

(f) "Industrial building" means a structure or space used for fabricating, assembling, manufacturing or processing products or materials, or for generating, storing or transmitting energy.

(g) "Mercantile building" means a structure or space used to provide or sell personal services, or to display and sell goods to the public.

(h) "Mobile home" means a prefinished, prefabricated dwelling unit that is delivered to the site on its own chassis and wheels.

(i) "Multifamily high-rise residential building" means a structure over four stories in height, comprised of a group of single or multilevel residences, structurally connected both horizontally and vertically.

(j) "Multifamily low-rise residential building" means a structure no more than four stories in height, comprised of a group of single or multilevel residences, structurally connected both horizontally and vertically.

(k) "Nursing home" means a structure or space other than a hospital, used for in-house nursing or health-related care, usually on a long-term basis.

(l) "Office building/large" means a structure or space other than a mercantile building, greater than 50,000 sq. ft. in area, used for the transaction of business or the rendering of professional services.

(m) "Office building/small" means a structure or space other than a mercantile building, less than or equal to 50,000 sq. ft. in area, used for the transaction of business or the rendering of professional services.

(n) "Restaurant/fast food" means a structure or space used for the preparation and sale of food on a limited-menu, self-service basis.

(o) "Restaurant/full menu/other" means a structure or space used for the preparation and sale of food and drink on a full menu basis, usually with table service but including cafeteria-style service.

(p) "School/elementary" means a structure or space used for academic instruction and/or care, typically for the first six grades.

(q) "School/secondary" means a structure or space used for academic or vocational instruction above the elementary school level, usually resulting in the award of a high-school diploma.

(r) "Single-family attached residential building" means a structure or space containing a dwelling unit which is structurally connected horizontally to at least one other such unit.

(s) "Single-family detached residential building" means a structure or space containing a dwelling unit which is not structurally connected to any other structure.

(t) "Warehouse" means a structure or space which is temperature controlled and is used for the storage of goods, merchandise, raw materials, manufactured products, or vehicles.

§ 435.7 Climatic zones and design temperature zones.

(a) The zone system depicted in Figure 1 establishes climatic zones for all building classifications except mobile homes.

(b) The zone system depicted in Figure 2 establishes design temperature zones for mobile homes.

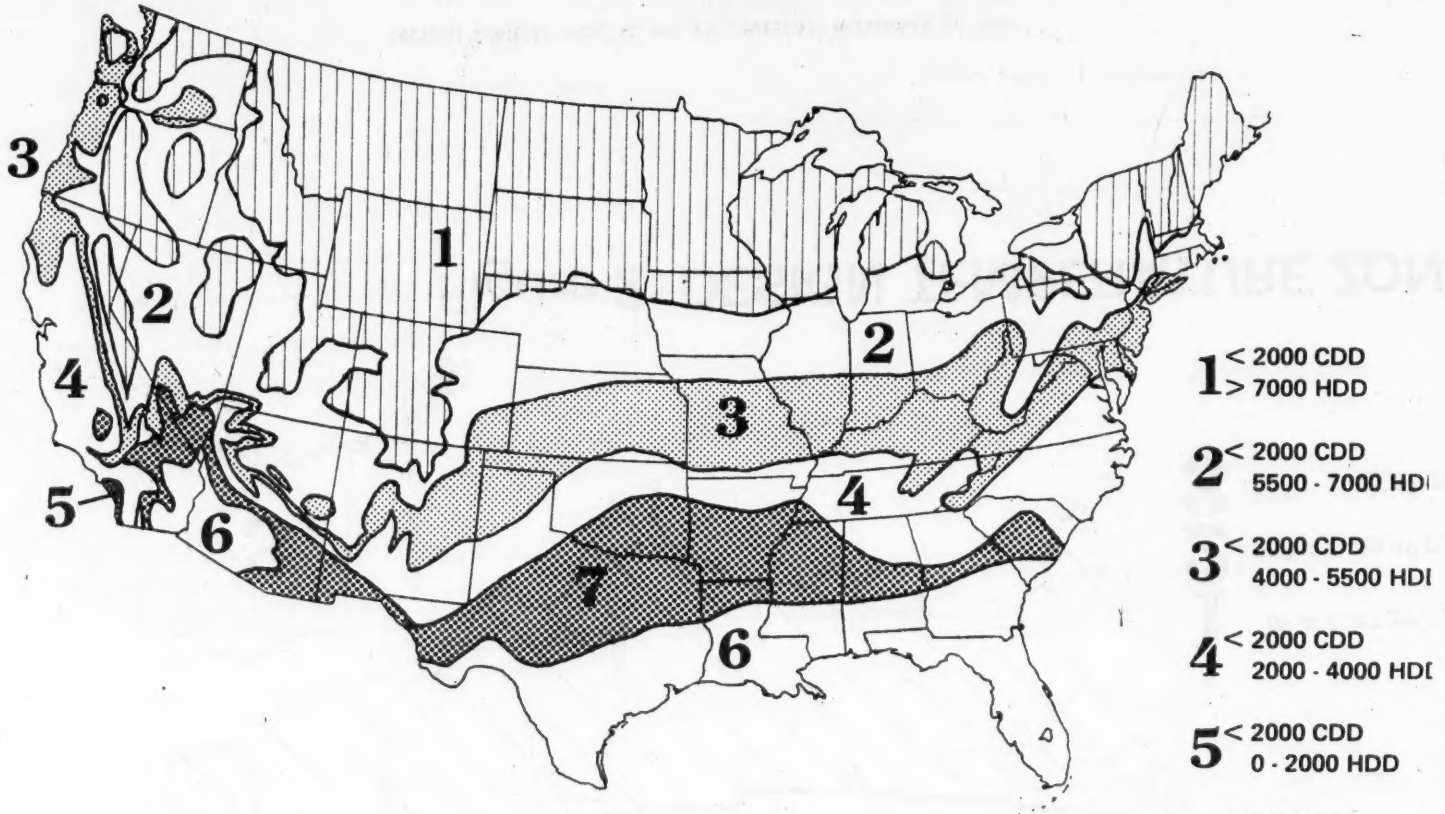

Figure 1: CLIMATIC ZONES

Figure 2: DESIGN TEMPERATURE ZONES

435.8 Design energy budgets.

(a) Design energy budgets are displayed in a matrix for each building classification as provided in § 435.6. The design energy budgets for each building classification are displayed by climatic zone as provided in §435.7.

(b) The following design energy budgets shall be used.

(NOTE: The design energy budgets displayed in this Preliminary Standards Format, including the methodology described in §435.8(b)(18), were developed based on only one of several possible approaches and are not to be considered the proposed or final design energy budgets to be promulgated in 1979.)

(1) Building classification: assembly.

(A) Design energy budget matrix. (SPACE RESERVED)

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET							

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(a) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied ____
   - Winter unoccupied ____
   - Summer occupied ____
   - Summer unoccupied ____
2. Occupancy density (sq. ft./person) ____
3. Annual occupancy (weeks/yr) ____
4. Daily occupancy (percentage of peak load) See (C)

(C) ASSEMBLY BUILDINGS

DAILY OCCUPANCY PROFILE (SPACE RESERVED)

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary. (Not applicable at this time.)

(2) Building classification: clinics.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	235.2	199.2	197.6	189.0	165.2	189.0	196.0

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(b) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 50
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) CLINICS

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	0	0	0
1			
2			
3			
4			
5			
6			
7	10	10	
8	50	30	5
9	80	40	
10			
11			
Noon			
1			
2			
3			
4			0
5	50	10	
6	30		
7		0	
8	20		
9			
10	0		
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II technical redesign data, as described in Section V.B.4.a(1)(b), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II technical redesign level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II TECHNICAL REDESIGN BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	98	83	76	70	59	63	70
COMBINED RUF	2.4	2.4	2.6	2.7	2.8	3.0	2.8

(3) Building classification: colleges or universities.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	134.4	124.0	163.8	162.5	150.0	197.5	143.9

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(c) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 150
3. Annual occupancy (weeks/yr): 35
4. Daily occupancy (percentage of peak load): See (C)

(C) COLLEGES OR UNIVERSITIES

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	0	0	0
1			
2			
3			
4			
5			
6			
7			
8			
9	100		
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7	0		
8			
9			
10			
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(c), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	64	62	63	65	60	79	65
COMBINED RUF	2.1	2.0	2.6	2.5	2.5	2.5	2.2

(4) Building classification: hospitals.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	345.0	375.0	384.0	359.1	393.3	517.5	410.4

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(d) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 72° F
   - Winter unoccupied: N/A
   - Summer occupied: 75° F
   - Summer unoccupied: N/A
2. Occupancy density (sq. ft./person): 100
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) . HOSPITALS

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	50	50	50
1			
2			
3			
4			
5			
6		60	60
7	70		
8	80	70	70
9			
10			
11			
Noon			
1			
2		90	90
3			
4			
5		70	70
6			
7		80	
8			
9	60	50	50
10	50		
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(d), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	138	150	160	171	171	225	171
COMBINED RUF	2.5	2.5	2.4	2.1	2.3	2.3	2.4

(5) Building classification: hotels or motels.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	240.0	217.5	232.4	189.6	184.6	226.2	229.1

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(e) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 300
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) HOTELS OR MOTELS

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	90	90	70
1			
2			
3			
4			
5			
6	70	70	
7	40	50	
8			50
9	20	30	
10			
11			30
Noon			
1			20
2			
3	30		
4	50		30
5		50	40
6		60	
7	70		60
8			
9	80	70	80
10	90		
11			
Midnight			70

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II technical redesign data, as described in Section V.B.4.a(1)(e), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II technical redesign level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II TECHNICAL REDESIGN BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	96	87	83	79	71	78	79
COMBINED RUF	2.5	2.5	2.8	2.4	2.6	2.9	2.9

(6) Building classification: industrial buildings.

(A) Design energy budget matrix. (SPACE RESERVED)

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET							

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(f) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied ____
   - Winter unoccupied ____
   - Summer occupied ____
   - Summer unoccupied ____
2. Occupancy density (sq. ft./person) ____
3. Annual occupancy (weeks/yr) ____
4. Daily occupancy (percentage of peak load) See (C)

(C) INDUSTRIAL BUILDINGS

DAILY OCCUPANCY PROFILE (SPACE RESERVED)

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary. (Not applicable at this time.)

(7) Building classification: mercantile buildings.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	249.6	212.5	226.8	212.8	201.0	234.0	228.0

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(g) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 50
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) MERCANTILE BUILDINGS

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	0	0	0
1			
2			
3			
4			
5			
6			
7	10	10	
8	20	20	
9	50	50	10
10		60	20
11	70	80	
Noon			40
1			
2			
3	80		
4	70		
5	50	60	20
6		20	10
7	30		0
8			
9	0	10	
10		0	
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(g), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	96	85	81	76	67	78	76
COMBINED RUF	2.6	2.5	2.8	3.0	3.0	3.0	3.0

(8) Building classification: mobile homes.

(A) Design energy budget matrix. (SPACE RESERVED)

DESIGN ENERGY BUDGET	ZONE	FUEL	SIZE (FT) 12 x 60	14 x 70	24 x 60	28 x 70
	1	GAS				
		OIL				
		ELEC.				
	2	GAS				
		OIL				
		ELEC.				
	3	GAS				
		OIL				
		ELEC.				

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

(SPACE RESERVED)

(C) (SPACE RESERVED)

(D) Commentary. (Not applicable at this time.)

(9) Building classification: multifamily high-rise residential buildings.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	112.0	109.2	110.0	137.2	119.6	150.0	147.1

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(h) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 300
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) MULTIFAMILY HIGH-RISE RESIDENTIAL BUILDINGS

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	95	95	95
1			
2			
3			
4			
5			
6			
7	80		90
8		80	
9	65		80
10		70	70
11			
Noon			
1			
2			
3			
4	80		80
5		80	
6	85	95	
7			95
8			
9	95		
10			
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II technical redesign data, as described in Section V.B.4.a(1)(h), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II technical redesign level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II TECHNICAL REDESIGN BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	56	52	50	49	46	50	49
COMBINED RUF	2.0	2.1	2.2	2.8	2.6	3.0	3.0

(10) Building classification: multifamily low-rise residential buildings.

(A) Design energy budget matrix. (SPACE RESERVED)

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET							

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(i) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied ____
   - Winter unoccupied ____
   - Summer occupied ____
   - Summer unoccupied ____
2. Occupancy density (sq. ft./person) ____
3. Annual occupancy (weeks/yr) ____
4. Daily occupancy (percentage of peak load) See (C)

(C) MULTIFAMILY LOW-RISE RESIDENTIAL BUILDINGS

DAILY OCCUPANCY PROFILE (SPACE RESERVED)

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary. (Not applicable at this time.)

(11) Building classification: nursing homes.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	300.0	255.0	268.8	216.0	192.4	295.8	261.0

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(j) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 72° F
   - Winter unoccupied: N/A
   - Summer occupied: 75° F
   - Summer unoccupied: N/A
2. Occupancy density (sq. ft./person): 300
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) NURSING HOMES

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	90	80	80
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(j), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	120	102	96	90	74	102	90
COMBINED RUF	2.5	2.5	2.8	2.4	2.6	2.9	2.9

(12) Building classification: offices/large (greater than 50,000 sq. ft.)

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	156.0	145.0	156.6	162.4	151.2	186.0	162.4

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(k) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 100
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) OFFICES/LARGE

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	0	0	0
1			
2			
3			
4			
5			
6	10	10	5
7	20		
8	95	30	
9			
10			
11			
Noon	50	10	
1	95		
2			
3			
4			
5	30	5	
6	10		0
7		0	
8			
9			
10	5		
11			
Midnight	0		

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(k), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	60	58	58	58	56	62	58
COMBINED RUF	2.6	2.5	2.7	2.8	2.7	3.0	2.8

(13) **Building classification:** offices/small (less than or equal to 50,000 sq. ft.)

(A) **Design energy budget matrix.**

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	145.6	137.5	148.5	148.4	143.1	180.0	154.0

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(1) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 100
3. Annual occupancy (weeks/yr): 52
4. Daily occupancy (percentage of peak load): See (C)

(C) OFFICES/SMALL

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	0	0	0
1			
2			
3			
4			
5			
6	10	10	5
7	20		
8	95	30	
9			
10			
11			
Noon	50	10	
1	95		
2			
3			
4			
5	30	5	
6	10		0
7		0	
8			
9			
10	5		
11			
Midnight	0		

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(1), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	56	55	55	53	53	60	55
COMBINED RUF	2.6	2.5	2.7	2.8	2.7	3.0	2.8

(14) Building classification: restaurants/fast food.

(A) Design energy budget matrix. (SPACE RESERVED)

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)							

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(m) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied ____
   - Winter unoccupied ____
   - Summer occupied ____
   - Summer unoccupied ____
2. Occupancy density (sq. ft./person) ____
3. Annual occupancy (weeks/yr) ____
4. Daily occupancy (percentage of peak load) See (C)

(C) RESTAURANTS/FAST FOOD
DAILY OCCUPANCY PROFILE (SPACE RESERVED)

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary. (Not applicable at this time.)

(15) Building classification: restaurants/ full menu/other

(A) Design energy budget matrix. (SPACE RESERVED)

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)							

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(n) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied ____
   - Winter unoccupied ____
   - Summer occupied ____
   - Summer unoccupied ____
2. Occupancy density (sq. ft./person) ____
3. Annual occupancy (weeks/yr) ____
4. Daily occupancy (percentage of peak load) See (C)

(C) RESTAURANTS/FULL-MENU/OTHER

DAILY OCCUPANCY PROFILE (SPACE RESERVED)

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary. (Not applicable at this time.)

(16) Building classification: schools/elementary.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	203.7	197.5	182.0	158.6	129.6	133.4	152.3

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(o) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 100
3. Annual occupancy (weeks/yr): 42
4. Daily occupancy (percentage of peak load): See (C)

(C) SCHOOLS/ELEMENTARY

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	0	0	0
1			
2			
3			
4			
5			
6			
7	5		
8	50		
9	80		
10			
11			
Noon			
1			
2	75		
3	30		
4	5		
5	0		
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(o), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	97	79	70	61	48	46	61
COMBINED RUF	2.1	2.5	2.6	2.6	2.7	2.9	2.5

(17) Building classification: schools/secondary.

(A) Design energy budget matrix.

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET (MBTU/SQ. FT./YR)	159.6	145.2	125.4	129.6	97.2	93.6	124.8

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(p) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied: 68° F
   - Winter unoccupied: 60° F
   - Summer occupied: 78° F
   - Summer unoccupied: Equipment off
2. Occupancy density (sq. ft./person): 150
3. Annual occupancy (weeks/yr): 42
4. Daily occupancy (percentage of peak load): See (C)

(C) SCHOOLS/SECONDARY

DAILY OCCUPANCY PROFILE

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight	2	2	2
1			
2			
3			
4			
5			
6			
7	5		
8	75	10	
9	90		
10			
11	80		
Noon			
1		2	
2			
3	45		
4	15		
5	5		
6	15		
7	20		
8			
9	10		
10	2		
11			
Midnight			

(D) Commentary.

The source-energy levels shown in paragraph A for the seven climatic zones were derived from the Phase II parametric data, as described in Section V.B.4.a(1)(p), and the combined RUF's, derived from the Phase I data, as described in Section V.B.4.b. These data are displayed in the following matrix.

The source-energy level for each zone was derived by multiplying the selected Phase II parametric baseline level by the combined RUF.

CLIMATIC ZONE	1	2	3	4	5	6	7
PHASE II PARAMETRIC BASELINE BUILDING LINE DESIGN ENERGY CONSUMPTION (MBTU/SQ. FT./YR)	84	66	57	48	36	36	48
COMBINED RUF	1.9	2.2	2.2	2.7	2.7	2.6	2.6

(18) Building classification: single-family attached residential structures.

(See note after §435.8(b).)

For single-family attached residential structures, the design energy budget shall be a floating value and shall be determined for each building design in accordance with the following procedure:

(A) Step 1: Determine the envelope construction and equipment sizes from the NAHB Thermal Performance Guidelines, incorporated by reference in this section.

(B) Step 2: For the heating system, determine the estimated design energy using the ASHRAE modified degree-day method described in the ASHRAE 1976 SYSTEMS HANDBOOK and Product Directory, Chapter 43, incorporated by reference in this section.

(C) Step 3: For the cooling system, determine the estimated design energy using the ASHRAE equivalent full-load hours method described in the ASHRAE 1976 SYSTEMS HANDBOOK and Product Directory, Chapter 43.

(D) Step 4: Convert the estimated heating design energy to the heating design energy budget in accordance with the following equation:

$$HDEB = \frac{E \times RUF}{A}$$

where, HDEB= heating design energy budget, Btu/sq. ft./yr

E = estimated design energy from ASHRAE 1976 SYSTEMS HANDBOOK and Product Directory

RUF = resource utilization factor for the fuel source used for heating in the climatic zone involved, determined in accordance with §435.9

A = area of building, sq. ft.

(E) Step 5: Convert the estimated cooling design energy to the cooling design energy budget in accordance with the following equation:

$$CDEB = \frac{T \times K \times EFLH \times 3413 \frac{Btu}{kWh} \times RUF}{A}$$

where, CDEB= cooling design energy budget, Btu/sq. ft./yr

T = installed tons of cooling system

K = conversion factor of kW/ton, from Table 4 in Equivalent Full-Load Hours method from ASHRAE 1976 SYSTEMS HANDBOOK and Product Directory, Chapter 43

EFLH= equivalent full-load hours, from Table 5 in Equivalent Full-Load Hours method from ASHRAE 1976 SYSTEMS HANDBOOK and Product Directory, Chapter 43

RUF = resource utilization factor for the fuel source used for cooling in the climatic zone involved, determined in accordance with § 435.9

A = area of building, sq. ft.

(F) Step 6: Sum the HDEB and CDEB of Steps 4 and 5 to arrive at the design energy budget for the building.

(19) Building classification: single-family detached residential structures.

(See note after §435.8(b).)

For single-family detached residential structures, the design energy budget shall be a floating value and shall be determined for each building design in accordance with the procedures described in § 435.8(b)(18).

(G) Step 7: Reevaluate the building design to determine allowable design changes which will not exceed the design energy budget established in Step 6, and revise the design, if desired, within the limits established in Step 6 and the first part of Step 7.

(20) Building classification: warehouses.

(A) Design energy budget matrix. (SPACE RESERVED)

CLIMATIC ZONE	1	2	3	4	5	6	7
DESIGN ENERGY BUDGET							

(The above figures were based only on the statistical analyses of existing buildings, as described in Section III and APPENDIX II. The proposed and final Standards will be based on an analysis of a much broader range of possible design energy budgets. See Section V.B.4.a(1)(#4) and paragraph D of this section.)

(B) The following operating profile is assumed for the design energy budgets for this building classification in all climate zones:

1. Indoor design temperatures:
   - Winter occupied ____
   - Winter unoccupied ____
   - Summer occupied ____
   - Summer unoccupied ____
2. Occupancy density (sq. ft./person) ____
3. Annual occupancy (weeks/yr) ____
4. Daily occupancy (percentage of peak load) See (C)

(C) WAREHOUSES
DAILY OCCUPANCY PROFILE (SPACE RESERVED)

TIME	WEEKDAYS	SATURDAY	SUNDAY
Midnight			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Noon			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
Midnight			

(D) Commentary. (Not applicable at this time.)

435.9 Evaluation technique.

(NOTE: This presentation is based on only one of a number of possible methods for incorporating RUF's and RIF's. It is not to be viewed as the only one which will be considered for the proposed or final Standards to be promulgated in 1979. DOE reserves the option to include more than one evaluation technique, if deemed appropriate.)

(a) The adjusted design energy consumption for a building design shall be calculated as follows:

(1) Step 1: Calculate the design energy consumption for each fuel type (gas, oil, electricity) using any one of the techniques described in the "Bibliography on Available Computer Programs in the General Area of Heating, Refrigerating, Air-Conditioning and Ventilating," ASHRAE, 1975, incorporated by reference in this section. Fuel usage attributable to process energy requirements shall be excluded from such calculations.

(2) Step 2: First, derive the RIF for each fuel type in each climatic zone by. . .

(SPACE RESERVED)

(The RIF for renewable resources shall be equal to zero.)

Then, multiply the design energy consumption for each fuel type calculated in Step 1 by the corresponding RIF for each fuel type.

(3) Step 3: First, determine the RUF for each fuel type in each climatic zone by. . .

(SPACE RESERVED)

(The RUF for renewable resources shall be equal to zero.)

Then, multiply the RIF-adjusted design energy consumption for each fuel type calculated in Step 2 by the RUF for each fuel type in each climatic zone, to arrive at the adjusted design energy consumption by fuel type.

(4) Step 4: Sum the adjusted design energy consumptions for each fuel type in a given climatic zone to arrive at the adjusted design energy consumption for the building design in that climate zone, in accordance with the following:

$$ADEC_B = (DEC_1 \times RIF_1 \times RUF_1)_{zone\ x} + (DEC_2 \times RIF_2 \times RUF_2)_{zone\ x} + (DEC_3 \times RIF_3 \times RUF_3)_{zone\ x}$$

where, $ADEC_B$ = adjusted design energy consumption for the building design

zone x = the climatic zone in which the building is planned for construction

DEC_1 = design energy consumption for fuel type 1 in zone x

RIF_1 = resource impact factor for fuel type 1 in zone x

RUF_1 = resource utilization factor for fuel type 1 in zone x

(b) The adjusted design energy consumption for the building design, calculated in paragraph (a) of this section, shall then be compared to the design energy budget for the building classification, obtained in accordance with §435.8. The building design shall be in compliance with these Standards if the adjusted design energy consumption for the building design does not exceed the design energy budget for the building classification.

APPENDIX II.

STATISTICAL ANALYSES PROGRAM.

A-II.A Phase I.

The objective of Phase I, which began in early 1977, was to establish a design baseline. Buildings designed after the 1973 oil embargo were used because it was felt that these structures would reflect discernable energy-conscious designs, as well as current design/construction technology.

Because the design energy consumption of a building is a function of the climatic conditions to which the building is exposed, and its physical characteristics and intended use, the first step of Phase I was to develop a building classification system and to identify climatic zones and the required design data. In the next step, a building sample was identified and the required design data on these buildings collected. Finally, the design energy consumptions of the sample buildings were calculated, using computer modeling techniques.

A-II.A.1 Building Classifications.

For data collection purposes, buildings were first divided into two major groups: nonresidential buildings (including schools, hospitals, offices, restaurants, stores, other commercial buildings and multifamily high-rise residential structures), and residential buildings (including single-family detached and attached structures, multifamily low-rise buildings and mobile homes). NOTE: Multifamily high-rise residential buildings were included in the nonresidential group because of their physical similarity to commercial high-rise buildings.

Two building classification schemes were then developed. The first was a General Classification System, which was derived from descriptions in existing building codes. The second, a Classification System for Data Collection, was derived from the first system but was limited to those specific building classifications for which data would be collected; i.e., building classifications which would contribute significantly to the volume of new construction and would demonstrate measurable energy needs for space heating and cooling.

The general building classifications thus developed for data collection purposes were: offices, elementary schools, secondary schools, colleges/universities, hospitals, clinics, public assembly buildings, restaurants, mercantile buildings, storage/warehouses, residential nonhousekeeping facilities, multifamily high-rise residential structures, single-family detached residential buildings, single-family attached residential buildings, multifamily low-rise residential buildings and mobile homes.

A-II.A.2 Climatic Classification.

In order to determine the method for classifying climatic conditions so that the building sample would adequately represent these variations, as specified in the enabling legislation, the climatic variables affecting energy consumption were first isolated and then a classification procedure based on heating and cooling degree-days was developed.

(A heating degree-day relates to the space heating requirement on a given day. This requirement is assumed to vary directly with the difference between 65° F and the average of the extreme temperatures occurring on that day, in Fahrenheit degrees. By definition, the number of heating degree-days associated with a given day is equal to this numerical difference in Fahrenheit temperature. For example, if the mean outdoor temperature on a day is 60° F, then the number of heating degree-days associated with that day is 65 - 60, or 5. A similar definition applies to cooling degree-days, also based on 65° F as the controlling temperature level.)

Through this classification method, seven climatic zones were defined (see Figure 1, APPENDIX I). Alaska is included in zone 1, and Hawaii in zone 5.

Finally, since mobile homes may be used anywhere, regardless of where they are constructed, a different zone system was used for such structures, a system identical to the one published in the HUD Mobile Home Standards. These three design temperature zones are depicted in Figure 2, APPENDIX I.

A-II.A.3 Nonresidential Buildings Data Collection and Analysis.

A-II.A.3.a Building Population Identification.

As indicated, in Section A-II.A, the nonresidential building population targeted for the survey was restricted to those designed after the 1973 oil embargo. The survey population was further refined to include only those buildings for which construction actually began as early as 1975 and 1976, because it was believed that the most complete data base would be available on these buildings.

A-II.A.3.b Survey Sample Selection.

Probability sampling techniques were used to select the survey sample. First, 37 Standard Metropolitan Statistical Areas (SMSA's) were selected as the survey sites. The SMSA's chosen were cities or areas with populations in excess of 250,000; they were also representative of the seven climatic zones. Then, within each of the SMSA's, a number of buildings, representing each building classification, was identified.

The buildings were identified, along with their designers/constructors, through Dodge Construction Reports for the time period defined. (These reports are published by the McGraw-Hill Publishing Company and detail ongoing construction in the various regions of the country.) Finally, a random sample of buildings, representing each classification in each SMSA, was selected. This random sample comprised approximately 3,200 buildings, from a total of 12,834 buildings identified as being designed after 1973 and for which construction began in 1975-1976.

A-II.A.3.c Data Requirements Identification.

The broad categories of design data identified for collection included: general information such as floor area, volume, and number of stories; building envelope and site-related orientation data; designed use and building functions; heating, ventilating and air-conditioning systems data; domestic hot water and lighting systems data; and the incorporation of renewable energy usage considerations.

A-II.A.3.d Data Collection.

A survey form, based on 100 to 125 data items per building, was designed. The content of this survey form was derived by condensing the larger data set needed. This was done by: (a) assuming standard values for certain design variables for each building classification; (b) utilizing simplified computer modeling techniques for the buildings; and (c) taking into consideration the ease with which the building designers/ constructors would be able to derive the data.

The survey forms were sent to the designers/constructors of the selected buildings, and each building was assigned to a regional field team trained to monitor and assist in the completion of the survey forms. As each form was completed by the designers/constructors, it was checked for completeness by the field team and then returned for final checking. Most of the forms required further contact with those involved in their completion, to verify the data or obtain additional information.

Of the 3,223 data collection forms mailed out, 1,869 were returned. Of these, 1,661, or 55%, of the forms were sufficiently complete to allow processing. Statistical studies have verified the representativeness of the data from the forms thus processed.

The control required to produce valid estimates from the building sample largely determined the organization of the data collection and related management activities. Since voluntary response to the survey, with no accounting for nonresponse, might have distorted the findings or produced insufficient returns for a representative data base, control procedures were instituted to insure adequate survey responses for the selected buildings and to account for all buildings selected for the sample. Special techniques were developed for managing and internally controlling the data forms through the various stages of collection and processing. These techniques included:

a test simulation of the data collection process; training of the field teams responsible for assisting the firms in completing the forms; regional management and control of the field teams; use of local professional support for the data collection; and telephone follow-ups to obtain additional data, clarify the data supplied, or compare the data received to similar information from nonrespondents.

A-II.A.3.e Data Processing and Analysis.

The major data processing objective was to estimate the annual design energy consumption for each of the sample buildings, tabulate the results and generate a matrix showing annual design energy consumption for each building classification and climatic zone. "Btu's per gross square foot per year" (Btu/sq. ft./yr) was selected as the consistent unit for expressing the annual design energy consumption. A subsequent analysis of other possible units, such as volume and surface/volume ratios, supported the validity of using this unit for nonresidential buildings.

Procedures for processing the data were developed to: check the data forms manually and by computer; enter the data form responses in the computerized data base; incorporate weather data and the assumed standardized variables specific to each building classification; store the output of the resulting simulations; maintain and update the data base; and monitor the progress of each sample building through the analysis process.

For the analysis itself, a short form of the AXCESS energy analysis computer program was utilized. This program was chosen because it satisfied the technical evaluation criteria and resource constraints of the project; i.e., it would produce reasonable estimates of the design energy consumptions of the selected buildings, and would accept data readily available and practical to collect from building designers/constructors. The AXCESS program, which is a proprietary program not in the public domain, was originally developed by the Edison Electric Institute and was intended for use by architects and engineers to evaluate building design alternatives.

The reports generated included summary graphs and matrices of the annual design energy consumptions for each building classification in each climatic zone. These graphs, etc., were constructed by calculating the number of buildings in the sample versus the range of annual design energy consumption for each building classification in each zone. It should be noted that the design energy consumptions were calculated individually for each building classification in each climatic zone.

A-II.A.4 Residential Buildings Data Collection and Analysis.

A-II.A.4.a Building Population Identification.

Similar to the nonresidential buildings analysis, only residential buildings constructed in the last half of 1975 and the first half of 1976 were included in the building population to be sampled. (NOTE: As previously stated, multifamily high-rise residential structures were included in the nonresidential group for data collection and analysis purposes, because of their physical similarity to commercial high-rise structures.)

A-II.A.4.b Survey Sample Selection.

For single-family detached, single-family attached and multifamily low-rise residential structures, an existing NAHB/RF survey was used. The survey sample was selected by contacting the residential construction members of the NAHB. Initially, postcards were sent to these members,

requesting information on the numbers and types of applicable residential buildings constructed between July 1, 1975, and June 30, 1976. Ten-thousand postcards were returned and were sorted according to building classification. These became the total sample for the indicated residential buildings.

For mobile homes, the survey sample was developed by compiling a mailing list of all mobile home manufacturers listed in the 1976 Redbook of Housing Manufacturers and the Directory/Census of Manufactured Housing. The mobile homes represented by the 675 manufacturers thus identified became the total sample for these structures.

A-II.A.4.c Data Requirements Identification.

The design data required for residential buildings included: structural configuration; envelope description, including walls, windows, doors, floors, roof, etc.; and heating, ventilating and air-conditioning systems.

A-II.A.4.d Data Collection.

For single-family detached and attached and multifamily low-rise residential buildings, detailed questionnaires were sent to the 10,000 builders who responded to the initial postcards. A total of 4,700 questionnaires were returned. Of these 4,300 were usable, representing 112,942 single-family detached, 12,660 single-family attached and 44,960 multifamily low-rise residential units. The representativeness of this sample was tested and verified by: (a) sorting the questionnaires by climatic zone; (b) contacting nonrespondents to compare the characteristics of their buildings with those of the buildings for which data were received; and (c) statistically analyzing the possible bias introduced by restricting the survey sample to NAHB members. The analysis determined that no discernible bias existed, considering the number of new residential buildings designed and constructed in the time period involved.

For mobile homes, the 675 manufacturers identified in the survey selection process were sent detailed questionnaires. The 289 that were completed and returned represented 48% of the existing plants involved in mobile home construction. Again, representativeness of the sample was tested and verified by contacting the nonrespondents to compare their mobile home designs to those of the mobile homes for which data were received.

A-II.A.4.e Data Processing and Analysis.

Design energy consumption was calculated for residential structures using a manual method based on the ASHRAE "Modified Degree Day Method," outlined in Chapter 43 of the ASHRAE 1976 SYSTEMS HANDBOOK and Product Directory. The process was computerized to reduce the processing time required for the large number of buildings in the sample. Again, Btu/sq. ft./yr was used as the consistent unit for expressing the design energy consumption.

Heat loss and heat gain were calculated for each exposure (north, south, east, west) of each residence, using heat loss and heat gain multipliers developed for various construction materials. Heating and cooling utilization factors were developed based on seasonal heating and cooling system efficiencies. The heat loss and heat gain, multiplied by the

appropriate utilization factors, yielded the estimated energy required to heat and cool the residences for one year; i.e., the annual design energy consumption.

In a manner similar to that for nonresidential buildings, summary graphs and matrices were constructed for each residential building classification, depicting annual design energy consumption by climatic zone.

A-II.B Phase II.

Essentially, two "redesign" programs were conducted as part of Phase II:

(1) technical redesigns

(2) building simulations

The first redesign program was applied to all building classifications; the second, to all except mobile homes.

A-II.B.1 Technical Redesign.

The Phase I analyses provided an initial baseline of design energy conservation in new buildings. The purpose of the technical redesign in Phase II was to determine the maximum level of energy conservation which could be incorporated into the designs of new buildings, given certain design limitations. These design instructions are explained in the following subsections, first for nonresidential buildings, then for single-family detached and single-family attached residential structures, and finally for mobile homes.

(NOTE: For the technical redesign, both multifamily high-rise and multifamily low-rise residential buildings were included in the nonresidential buildings redesign program.)

A-II.B.1.a Nonresidential Buildings.

For the technical redesign for nonresidential buildings, 168 representative buildings were selected from the Phase I sample, using a process intended to include all of the applicable building classifications and climatic zones. The original design teams for those buildings were contracted to redesign their own buildings for maximum design energy conservation, based on their professional judgment. The instructions they received for the redesign were as follows:

1. Program: Use the original client program for the building. If the building was originally intended as a 500-bed hospital and specified a director's office with a river view, the redesigned building must also conform to these requirements. However, it is acceptable to distinguish between fixed and flexible requirements and to consider changes accordingly. For example, the square-footage of the building may be adjusted or partitions and floor plans changed, where such changes will not disrupt functional needs or the original program requirement. Documentation should show the scheduled hours of operation and justify any changes in the original schedule on the basis of resulting energy savings.
2. Dollar Budget: Observe the original dollar budget guidelines, at least in general. Use discretion in designing an energy conserving building that stays within a reasonable dollar budget, given its client's functional requirements. A speculative office building, for example, must be redesigned

as such, with the cost constraints that implies. A luxury building demanding exotic lobby treatments must still conform to client expectations. Preliminary studies indicate that, in many cases, the designs reflecting minimum energy consumption will cost no more than the original designs. However, where the cost of the redesign is estimated to be higher, modifying the original dollar budget may be considered, as professional judgment dictates. Documentation need not include precise cost calculations, but should include the approximate change in cost between the redesign and the original design, in terms of both percentages and actual dollar values.

3. Codes: Consider modifications to existing building codes, according to professional judgment and discretion, where those codes severely limit reasonable design energy consumption reductions. Many states have "health and safety equivalents" as supplements to their building codes; such criteria should be used where energy consumption is at issue. Where code changes are utilized, the changes should be documented and justified in terms of minimizing design energy consumption. In all other cases, observe the existing codes in the redesigns, as in the original designs.

4. Location:

   a. Site: Use the original site; however, consider changing the location or orientation of the building on the site, if such changes would reduce the design energy consumption. Observe the real constraints of the site, existing adjacent sites, and area infrastructure and development.

   b. Landscaping: Consider changes in surfaces, topography, planting and other controllable variables in relation to wind, sun, water and other potential energy factors. Do not assume unrealistic situations, such as 100-year-old-trees, where they do not exist.

5. Form:

   a. Configuration: Consider changing the configuration of the original building, provided the change is an appropriate solution for the building and its location.

   b. Circulation: Consider changing interior and exterior circulation patterns, provided the changes are appropriate to the building's location, functions, and health and safety requirements.

   c. Envelope: Consider changes in materials, openings, fenestration, insulation, color, surfaces, shade and wind controls, and other features.

6. Metabolism:

   a. Illumination: Consider changes in lighting, such as types, placement or number of lamps and fixtures, where they exceed functional requirements.

b. Climatic Control Systems: Consider changing and/or optimizing thermal and climatic systems, reduce loads to the maximum degree possible, and size the equipment to effect minimum design energy consumption.

c. Electrical and Control Systems: Consider installing and/or modifying control systems to minimize the design energy consumption; consider alternatives according to building design and functional requirements.

7. Solar and Wind Systems: Do not include recognizable, installed solar and wind systems, such as wind generators and active solar systems and equipment, unless used in the original building design. However, the passive utilization of renewable energy sources may be considered in order to reduce electrical and fossil-fuel loads. Examples include natural daylighting, natural ventilation, passive solar heat gain, and thermal mass storage and reradiation.

8. Raw-Source Energy: Do not include raw-source energy considerations (e.g., gas from well, to utility, to building. etc.). However, the redesign should conform to the concepts of appropriate technology, and the energy systems chosen should be appropriate to their task and to the supply and economics of the alternative fuels in the building's location. For example, lighting systems rely on electricity, but other energy sources may be appropriate for other building loads.

9. Documentation: Document the design decisions and trade-offs so that the concepts and processes, as well as the results, of the redesign may be properly recorded and analyzed. Justify decisions to modify program codes, costs or other constraints and explain such changes in sufficient detail for their impacts to be evaluated. Record the original conditions, the changes, the reasons for the changes and their estimated impacts, both positive and negative.

10. Data: Provide sufficient data on the building redesigns for a computer analysis using the long form of the AXCESS program.

A-II.B.1.b Single-Family Detached and Single-Family Attached Residential Buildings.

Designers and builders recognized for their experience in energy-conscious designs, were contracted to design prototype single-family detached and attached residential structures, based on: (a) specific building size/type/climatic zone combinations derived from the median characteristics of the buildings in the Phase I sample, and (b) defined cost limitations. The design sizes/types in each climatic zone were determined by construction volume and by variations in design energy consumption. as demonstrated in the Phase I data for single-family detached and attached residential buildings. Also, specific cities in each climatic zone were selected for the assumed building locations, to ensure geographic representation.

Each building was designed for each of the four alternative entrance orientations: north, south, east and west. Specific design rules provided to the designers and builders were as follows:

1. Human Comfort: Provide currently acceptable levels of human comfort within reasonable ranges of variation.

2. Life/Safety: Satisfy reasonable requirements for life/safety.

3. Feasibility: Satisfy "buildability" requirements; i.e.,

reasonably available materials, construction techniques and skills.

4. Codes: Consider deviating from existing codes, as professional judgment dictates, when those codes limit the incorporation of reasonable energy conserving design features. Carefully document the code changes and justify the deviations in terms of minimizing design energy consumption. In all other cases, observe existing codes as in any building design.

5. Site: Within the specified site size, climatic zone and topology, consider changes in surface, planting and other controllable elements. When such elements are introduced, include their cost in the building cost estimates. Do not consider unrealistic situations, such as 100-year-old trees or non-indigenous vegetation.

6. Mechanical-Electrical Systems: Design climate control systems for all reasonably available system types compatible with the building design.

a. Lighting: Examine lighting requirements with respect to task requirements. Consider various lighting types and quantities, as well as natural daylighting.

b. Control Systems: Consider control systems for mechanical-electrical systems, where such control systems would contribute to minimizing the design energy consumption.

c. Energy Loads: Consider energy loads such as major household appliances in the prototype design, even though estimates of design energy consumption will only include requirements for space conditioning and domestic hot water.

7. User Participation: Consider user participation in the operation of energy conserving features of the building.

8. Solar and Wind Systems: Do not include recognizable, installed solar and wind systems, such as wind generators and active solar systems and equipment, in the designs. However, passive techniques, such as natural daylighting, natural ventilation, passive solar heat gain or thermal mass storage and reradiation, may be considered.

9. Floor Area: Include in the floor area only the gross area of conditioned space, including finished basement areas. Do not include unfinished basement areas, garages and other unconditioned spaces.

10. Documentation: Include in the documentation on the design: (a) a general commentary on the process by which the energy related design decisions were made, and the assumptions, parameters and conflicts involved; (b) a quantitative analysis of options considered; (c) all code deviations, along with appropriate justifications; (d) a summary cost statement covering estimated building construction costs and, if appropriate, a comparison of first costs with anticipated energy cost savings over time; (e) a detailed estimate of annual design energy consumption for the completed design, with estimates for heating, cooling, lighting, hot water and appliances, and the calculation method clearly identified.

A-II.B.1.c Mobile Homes.

A prototype design program similar to the one used for single-family residential buildings was employed for the mobile home classification. It was determined that all mobile homes were already meeting the requirements of the current Federal standards published by

HUD. It was then possible to reduce the 21 different size models found in the Phase I survey to four nominal models for the prototype design program: 12' x 60', 14' x 70', 24' x 60', and 28' x 70'. One mobile home manufacturer was contracted to do the prototype designs, and the designs were reviewed by a Technical Advisory Group composed of other mobile home designers and manufacturers.

Floor plans and complete structural specifications were drawn up for each of the four units, energy-saving elements were incrementally added by computer simulation to each component, and a complete energy analysis was prepared. This process became the first maximum technically feasible redesign (MTFD-I) and included such elements as: added insulation, structural modifications, component modifications, etc.

For MTFD-I, five conditions had to be satisfied:

(1) that the changes require no alteration in the owner's lifestyle;

(2) that the unit be suitable for mass production and use readily available materials and foreseeable design strategies;

(3) that the unit meet reasonable requirements for life/safety;

(4) that the unit be transportable over present highways within existing regulations; and

(5) that the size of the unit satisfy prevailing mobile home park space limitations.

In summary, MTFD-I represented designs over which the manufacturer had total control under present marketing and regulatory conditions.

In developing the MTFD-I designs, it was discovered that, if the orientation of the unit on the site could be predicted and specific landscaping and other features could be dictated, additional substantive energy savings could be realized. Therefore, MTFD-II was developed, incorporating these concepts and additional structural/component modifications which may have been unusable given the conditions specified for MTFD-I.

Again, an energy analysis was conducted, and MTFD-I and MTFD-II became the mobile home technical redesigns for Phase II.

A-II.B.2 Building Design Simulations.

Building designs included in the technical redesign were also simulated. The data was modified to comply with minimum requirements of existing energy standards; i.e., ASHRAE 90-75R, the NAHB Thermal Performance Guidelines (NAHB/TPG) and the HUD Minimum Property Standards (HUD/MPS). Specifically, all of the nonresidential building designs in the technical redesign sample were simulated according to ASHRAE 90-75R; and residential building designs were simulated according to the NAHB/TPG and the HUD/MPS. Since mobile homes were already being designed to Federal standards, they were not included in this particular program.

Standard-based simulations were done on a component basis, using the maximum allowable energy consumption for each component. A subcommittee of the Technical Advisory Group, including ASHRAE representatives, reviewed these simulations to ensure that the standards were fairly and accurately represented and that the latest version of each standard was used.

A-II.B.3 Comparison Study of Design Energy Analysis Programs.

A comparison study of various design energy analysis programs, including those used during the course of Phases I and II, is being conducted. AXCESS, DOE-1 (formerly, CAL-ERDA) and CERL BLAST, the last two of which are in the public domain, and a manual method being developed by ASHRAE Technical Committee 4.7, are all being compared to determine the range of calculated design energy consumptions which are possible, given four reasonably sophisticated calculating procedures. Preliminary results of this comparison study are expected to be available at the time of publication of this ANPR.

A-II.B.4 Parametric Modeling.

The Phase I and Phase II data and analyses provide estimates of the design energy consumption distribution for nonresidential and multifamily high-rise residential buildings for three conditions: as designed, technically redesigned, and standard-based simulated. However, these estimates are valid only for the building designs included in the sample, not for the total population of buildings which the sample represents. To estimate the design energy consumption distribution for the entire universe of new nonresidential and multifamily high-rise residential buildings, it was necessary to develop a parametric model using statistical regression analysis techniques.

The model used the 1661 Phase I nonresidential buildings (including multifamily high-rise residential buildings) as the foundation for the projections to the total new construction universe for these building classifications. The projections for each building classification were presented for each 500 degree-day increment of heating and cooling degree-days. This resulted in design energy consumption levels for the best-case weather conditions through the worst-case weather conditions in each climatic zone. (The levels reflected for the worst-case in each climatic zone were subsequently used as the baseline for the preliminary design energy budget selection programs.)

The parametric model and resulting data were statistically evaluated in an independent effort to determine the validity of this program. The results of that evaluation confirmed the representativeness of the model data with respect to the total new construction universe for nonresidential and multifamily high-rise residential buildings designed after 1973 and constructed on or before 1976.

A-II.B.5 Reevaluation Studies.

In the course of Phase II, several reevaluation studies have been or are being conducted.

The first involves investigating anomalies in the data and analyses. The objective is to explain the anomalies and either: accept the anomalies as valid; discard them as insignificant; or reject them as invalid and collect additional data and/or conduct new analyses, as required.

The second reevaluation study involves examining the building classifications on the basis of design energy consumption, assumed operating profiles, similarities in intended use, etc. The objective of this study is to derive a system which will most accurately differentiate between the various elements, providing a clear distinction between the design energy budgets for each classification.

A third study involves examining the concept of expressing the design energy budgets by fuel type, as well as building classification and climatic zone.

Finally, a study is being conducted to correlate the square-footage represented by the buildings in the samples to the total estimated square-footage for all new construction for the respective time periods involved.

The preliminary results of these and other such programs can be seen in the preliminary Standards portion of this ANPR. For instance: (a) preliminary design energy budgets for several building classifications are not included because data/analysis anomalies require further investigation; (b) the tentative building classifications included are more detailed than those used in Phase I; and (c) the system tentatively considered for determining the design energy budgets for residential buildings includes fuel type factors.

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